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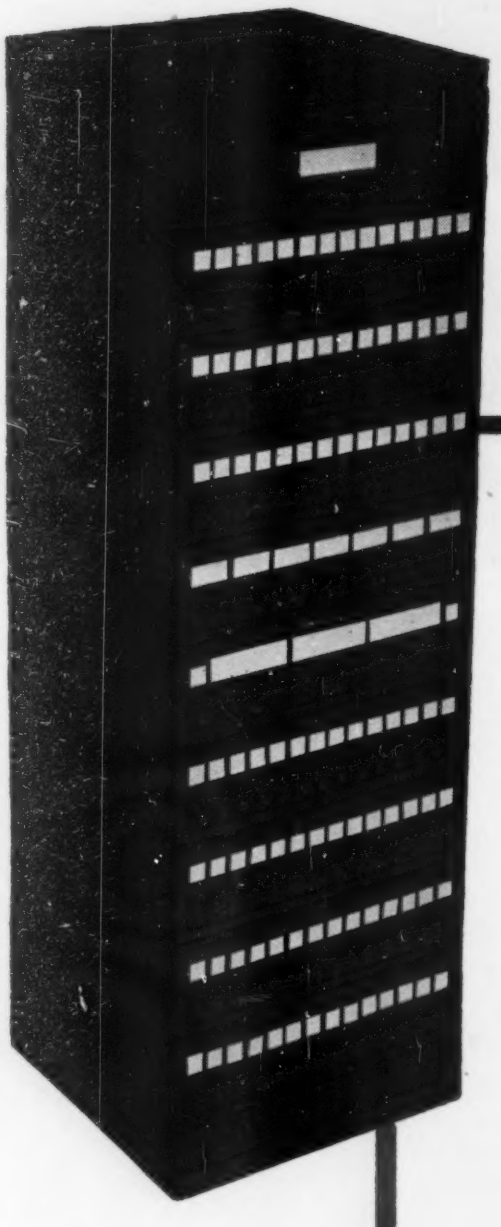
(See page 71)



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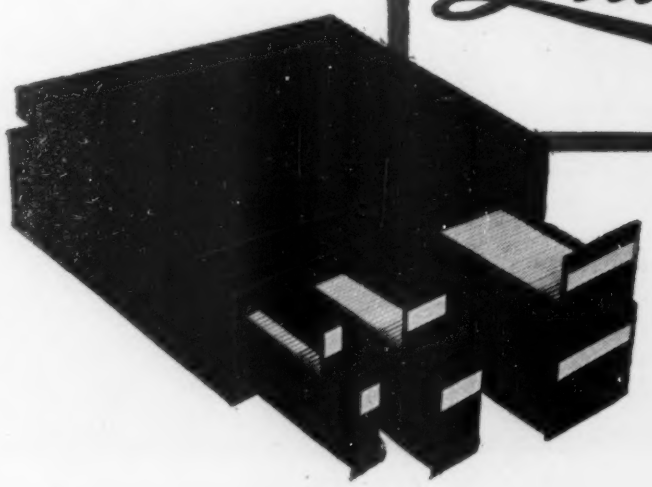

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SEXUAL BEHAVIOR in The HUMAN MALE

By ALFRED C. KINSEY, Professor of Zoology; WARDELL B. POMEROY, and CLYDE E. MARTIN, Research Associates, Indiana University. Based on Surveys made by Members of the Staff of Indiana University and supported by the National Research Council's Committee for Research on the Problems of Sex by means of funds contributed by the Medical Division of the Rockefeller Foundation. 804 pages, 6″ × 9″, with 173 charts and 159 tables. $6.50.

The Quarterly Review of Biology—

"... once in a great while a book comes along which marks the commencement, not the climax or end, of a scientific era. These are the books that virtually begin a new science, that blaze a trail into the unknown. Such a book is 'Sexual Behavior in the Human Male.' ... In all these respects the data show remarkable consistency and reveal a high order of validity. The conclusion one is entitled to make, therefore, is that the histories of sexual behavior are statistically reliable data. ... The reader ... can come at the end to but one conclusion. Here is a study of heroic magnitude, carefully planned, patiently amassed, cautiously evaluated. It carries an overwhelming conviction of the honesty and reliability of its conclusions."

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X-Ray, Electron, and Neutron Diffraction

C. G. Shull and E. O. Wollan

Oak Ridge National Laboratory, Oak Ridge, Tennessee

THE CONTRIBUTIONS WHICH HAVE BEEN made to our knowledge of atomic, molecular, and crystalline structure by studies involving X-ray diffraction constitute a well-known chapter in the progress of physics. This is to some extent also true of the newer field of electron diffraction. The new field of neutron diffraction, which has been made possible by chain-reacting piles, promises to be a useful partner to the above fields in molecular and crystal structure studies. The application of X-ray and electron diffraction techniques to structure studies has been compared in several books and articles on this subject. In this article some comparisons will be made of the results which can be obtained by these three techniques, and their advantages and disadvantages in particular applications will be outlined. The relatively small amount of work which has so far been carried out in the field of neutron diffraction will, of necessity, limit the scope of these comparisons, but it is hoped that they will show, in part at least, the significance of the new entry in the field of structure studies.

Characteristics of the Radiations

Although the radiations or particles with which we are here concerned, namely, photons, electrons, and neutrons, have widely different physical characteristics, they have the one property in common that there is associated with each a wave length which depends on the energy of the particular particle. The wave lengths which are useful in the study of crystal and molecular structure must be of the order of the distance between atoms in crystals or molecules in order that noticeable diffraction effects will be observed. Since atomic spacings are of the order of an angstrom, the useful wave length range will lie in the region from about 0.1 A to 10 A. With the proper choice of energy, X-rays, electrons, and neutrons can all be obtained with wave lengths lying in this region. Fig. 1 shows the relation between the energy and the wave length for these three radiations.

The nature of the sources and the intensity distribution as a function of wave length which can be obtained from these sources is very different for the three kinds of radiation. The radiation from an X-ray tube consists of the general radiation with a continuous distribution of wave lengths and the monochromatic line radiation which is characteristic of the target material. Both the general and the line radiation have been found useful in connection with the application of X-rays to structure studies, but if it had not been for the presence in X-rays of sharp monochromatic lines, a very serious handicap would have been placed on the technique, and much of the work which has been done would not have been possible. An appreciable fraction of the total energy from an X-ray tube is concentrated in these lines, and for many crystal structure studies this line radiation can be used directly without any further monochromatizing device being required. Where it is necessary to have a pure monochromatic source, as in experiments on the scattering by liquids and gases, balanced filters may be used or the line radiation may be reflected from a crystal and the general radiation thus eliminated. The general radiation from an X-ray tube is used in the application of Laue photography to structure studies.

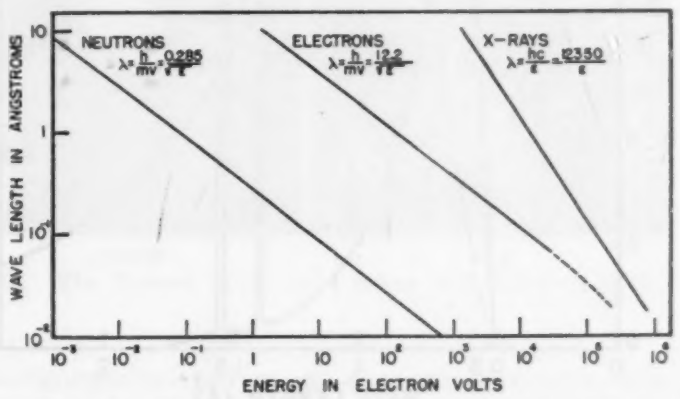

FIG. 1. Comparison of the relationship between particle wave length and energy for X-rays, electrons, and neutrons.

In electron diffraction studies the electron beam is universally obtained by the direct acceleration of the charged particles through electric potentials of the order of 30–50 kv, and this constitutes a monochromatic source of electrons within the limits of stability of the applied potential. Neutron sources, on the other hand, are essentially heterogeneous. In the chain reactor, which is by far the most powerful neutron source available, neutrons are produced in the fission process with wave lengths much too small for diffraction purposes. These neutrons are, how-

ever, slowed down in the moderating substance of the pile until they are in approximate thermal equilibrium with the atoms making up the moderator. A beam of such neutrons from a chain reactor is found to possess a nearly Maxwellian distribution of neutron velocities corresponding to a wave length distribution with a maximum intensity in the region of 1 A–2 A. The wave lengths in such a beam are in the desired region for diffraction experiments but, as such, their application would be restricted, as in the case of the general radiation from an X-ray tube, to techniques requiring a continuous distribution of wave length such as Laue photography. Monochromatic beams can, however, be obtained from the thermal beam by use of either a velocity selector or a crystal monochromator in which a narrow band is picked out of the continuous distribution.

Fig. 2 gives a comparison of the intensity distribution from X-ray, electron, and neutron sources. With slow neutrons only sources with a distribution

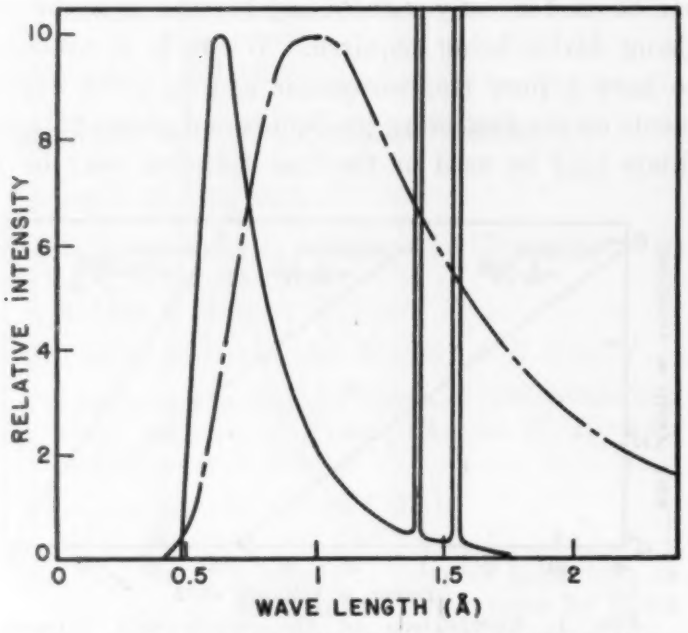

FIG. 2. The spectral distribution of radiation from various sources. The solid line represents the spectrum from a Cu target X-ray tube operated at 25 kv. The dashed line gives the approximate spectral distribution of neutrons from the Oak Ridge reactor.

of energies are obtainable. With electrons a monochromatic source of any desired wave length in the region of interest can be readily obtained. The radiation from an X-ray tube, on the other hand, gives both the general radiation with a distribution in energy and a wide choice of sharp monochromatic lines whose wave length depends on the target material.

The nature of the interaction of X-rays, electrons, and neutrons with individual atoms and nuclei is found to be very different for the three types of radiations. The scattering of X-rays by atoms takes place almost entirely from the electronic cloud surrounding the atomic nucleus, there being negligible scattering by the nucleus itself. Since the electrons are distributed over the atomic volume, which has a linear extent of about 1 A, and since this is of the same magnitude as the X-ray wave length, pronounced interference effects are to be expected in the scattering by individual atoms. This takes the form of an intensity reduction in the scattering at larger angles and is described by the conventional X-ray *form factor*. In the scattering of electrons by atoms, however, nuclear scattering is no longer negligible in comparison with the electronic scattering, so that additional interference effects are found for this case. The form factor for scattering of electrons is even more pronounced than it is for X-rays. As illustrations of this form factor scattering, Fig. 3 shows the decline in scattering amplitude

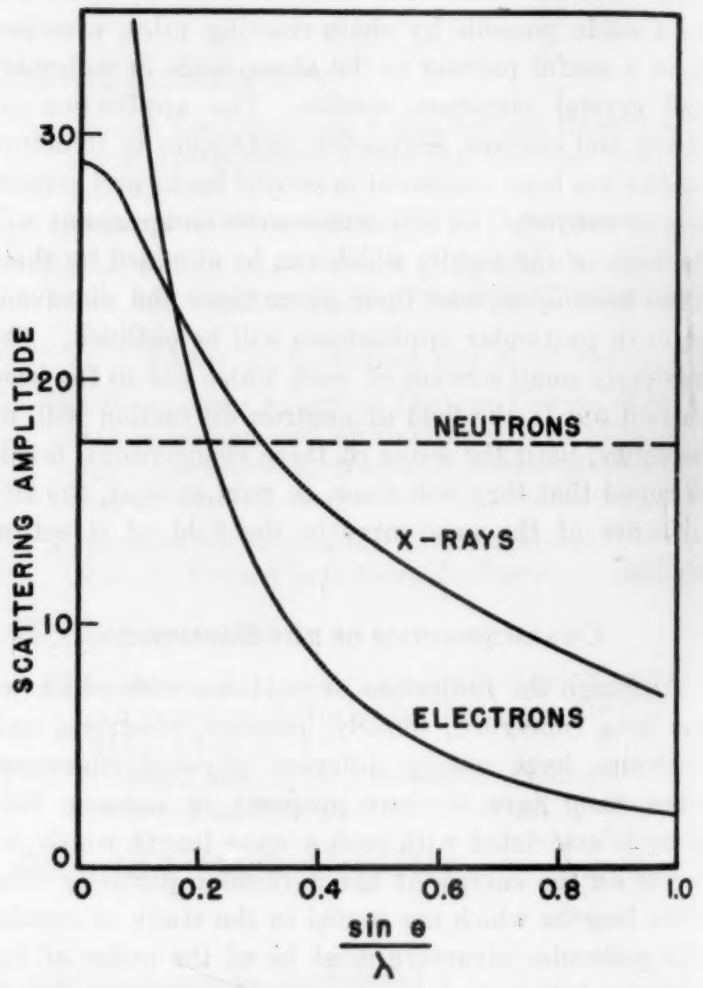

FIG. 3. Amplitude of scattering by copper atoms for various radiations.

with $\frac{\sin\theta}{\lambda}$ for the case of X-ray and electron scattering by copper atoms. In contrast, the amplitude of neutron scattering is shown as isotropic. This occurs because neutron scattering is caused overwhelmingly by interaction with the atomic nucleus, the neutron-electron interaction being usually negligible in comparison. The scattering is isotropic for such cases because the neutron wave length, being of the order of 10^{-8} cm, is so much larger than the physical size of the nucleus, which is of the order of 10^{-13} cm.

The form factors for X-rays and electrons represent the scattering amplitude for an atom relative to that for a single bound electron. The absolute scattering amplitudes for X-rays and electrons can be determined from the theoretically known scattering amplitude for a single electron. These theoretical scattering formulas have been well verified by scattering experiments. In the case of neutrons it is, however, not possible to make accurate calculations of scattering amplitudes, but they have been determined experimentally for a large number of nuclei. Scattering cross sections, which are proportional to the square of the scattering amplitudes, are of the same order of magnitude for X-rays and neutrons, but for electrons they are larger by a factor of several million. Table 1 lists the absolute scattering cross section per unit solid angle for X-rays, electrons, and neutrons for several elements. Since the cross sections for X-rays and electrons vary with scattering angle, they have been evaluated at the definite value of $\frac{\sin\theta}{\lambda} = 0.2$, while for neutrons this is not necessary, since the scattering by bound nuclei is isotropic.

TABLE 1

DIFFERENTIAL SCATTERING CROSS SECTIONS FOR VARIOUS SCATTERING CENTERS

	Neutrons	X-rays	Electrons
H	0.16	0.012	9.7×10^6
D	0.33	0.012	
C	0.38	0.48	320×10^6
O	0.33	1.5	260×10^6
Cl	1.04	6.7	$1{,}160 \times 10^6$
Cu	0.56	24	$2{,}070 \times 10^6$
Pb	0.79	240	$7{,}500 \times 10^6$

All values calculated for $\frac{\sin\theta}{\lambda} = 0.2$ and are in units of barns ($= 10^{-24}$ cm^2).

In structure determinations the absolute scattering cross sections are not important as long as there is sufficient scattering by the sample. The relative scattering by the different atoms or nuclei in a crystal or molecule will be the determining factor in structure analysis. With X-rays and electrons the scattering by a hydrogen atom which has only a single electron will be very weak compared to the scattering by atoms of larger atomic number, since the amplitude increases about linearly with atomic number. With neutrons there is no regular variation of the scattering amplitudes from one element to the next, and hydrogen and deuterium have scattering cross sections comparable to other elements; hence, structure determinations involving these nuclei may be much more feasible with neutrons than with X-rays and electrons.

LAUE PHOTOGRAPHY

Since the neutron radiation available from reactor sources possesses a continuous distribution of wave lengths, it would seem most feasible to use this radiation with the Laue technique, which requires such a distribution. The Laue pattern, however, is of a two-dimensional nature, so that photographic detection of the pattern is necessary to make it of general usefulness and the photographic detection of neutrons presents problems not encountered in the X-ray and electron techniques. Neutrons, being nonionizing in their passage through matter, have practically no direct action on photographic emulsions. They can be detected indirectly, however, by placing some strong neutron-absorbing material either next to or combined with the emulsion, in which case the secondary radiations (electrons, α-particles, γ-rays) given off upon neutron capture may cause photographic action. The determination of the optimum conditions for such systems of activating substance plus emulsion has not yet been extensively explored, but by placing an indium sheet next to X-ray film, Laue photographs with neutrons have been obtained with exposure times of about 10 hrs. Some tests made with the addition of fluorescent screen material to the above activator-

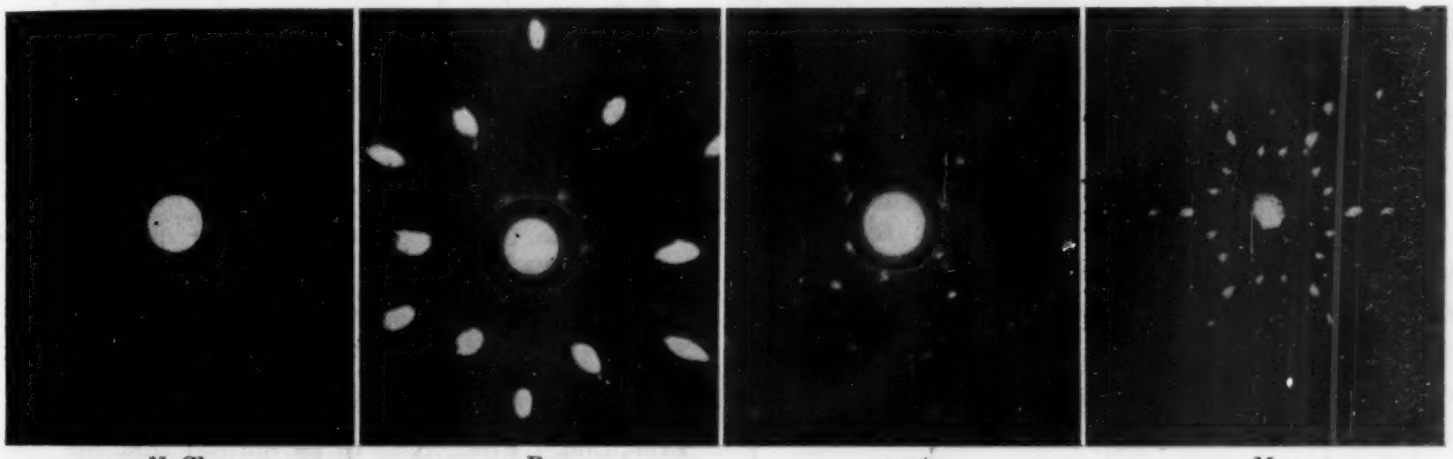

FIG. 4. Laue photographs taken with NaCl, Be, quartz, and Mg. The former three were taken with neutron radiation; the latter, with X-rays.

film combination have indicated this to be a promising technique, so that the required exposure time may be very much reduced—possibly into the range of X-ray exposure times of the order of 15 min.

Fig. 4 shows examples of neutron diffraction Laue patterns taken with single crystals of NaCl, Be, and quartz and, for comparison purposes, an X-ray diffraction Laue pattern taken with a magnesium crystal. Laue patterns are generally not taken with electrons because (a) extremely small crystals would be necessary because of the low penetrating power of electrons and (b) the heterogeneous nature of the required radiation (all wave lengths) is not easily obtained from electron sources. The quartz pattern of Fig. 4 shows the characteristic elliptical pattern of spots caused by reflections from the various planes passing through a particular zone axis. The spots in Laue patterns always fall in an elliptical array, but this may not always be as apparent as in the quartz pattern. The distorted appearance of the spots in the patterns for beryllium and magnesium is an indication of crystal imperfections and distortions in the metal crystals. The hexagonal symmetry in the metal patterns is clearly discernible.

Diffraction by Crystalline Powders

The Debye-Scherrer-Hull technique, in which a crystalline powder is illuminated with monochromatic radiation, has been widely used in diffraction studies.

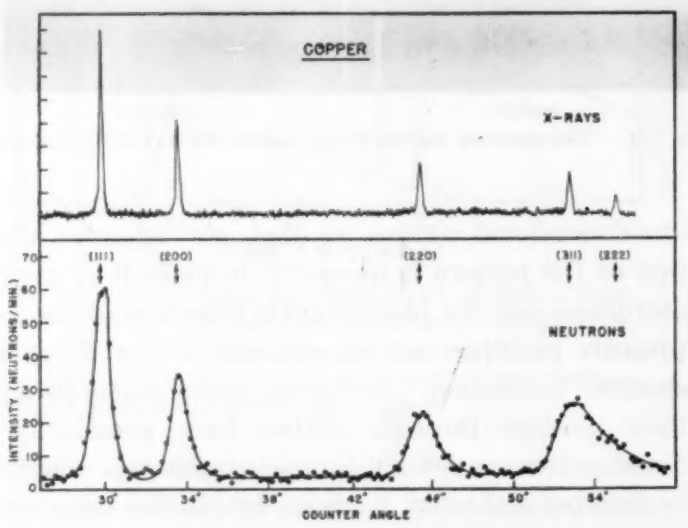

Fig. 5. X-ray and neutron powder diffraction patterns taken with copper powder. The lower resolution obtainable with presently available neutron sources is to be noted. Also of interest is the form factor decrease of X-ray intensity at the higher angles. The integrated intensities of the (311) and (111) neutron peaks are about equal, whereas with X-rays they are as 1 : 3.

This technique not only has the advantage of not requiring single crystals of the material to be examined, but offers as well the best procedure for obtaining absolute values of scattered intensity. With X-rays the characteristic radiation from a specific target material has been used as the source of monochromatic radiation, whereas with neutrons a crystal monochromator has been used to select a monochromatic slice of radiation from the continuous distribution of wave lengths present in pile radiation.

Figs. 5 and 6 show comparative X-ray and neutron diffraction powder patterns for examples of Cu and MnO. The X-ray patterns were kindly obtained for us by Dr. M. A. Bredig using a Philips Geiger-counter spectrometer, whereas the neutron patterns were obtained on the neutron diffraction powder spectrometer in use at Oak Ridge. Both spectrometers are of the automatic operation type. The patterns for Cu are very similar with two points of

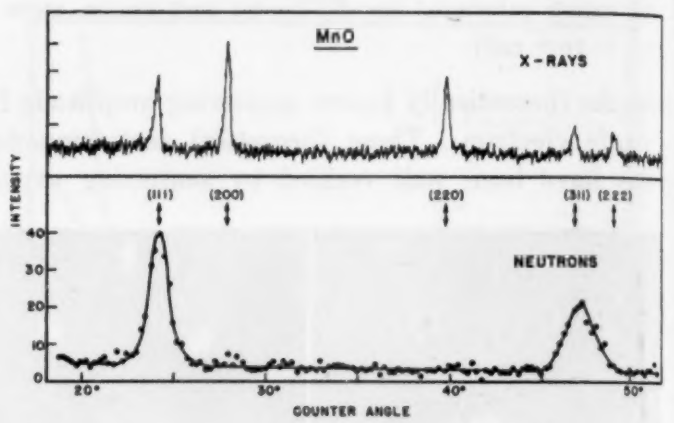

Fig. 6. X-ray and neutron powder diffraction patterns taken with MnO. The pronounced pattern differences are caused by the reversed phase of neutron scattering by Mn nuclei as compared to that by O nuclei. With X-rays, the scattering by the two atoms is of the same phase.

exception. First, it is to be noticed that the resolution in the X-ray pattern is about three times better than that shown for the neutron pattern. This is a consequence of the less refined geometry encountered in the neutron study as necessitated by the much lower intensity available. For the patterns produced by crystals possessing high symmetry where the diffraction lines are well separated, the limited resolution in the neutron pattern is not of serious consequence but for crystals of lower symmetry (rhombohedral, trigonal, etc.) this may be troublesome in showing unresolved peaks. A second point of interest in the Cu pattern is the form factor decrease of intensity at the higher angles for X-ray diffraction as compared to neutron diffraction.

The diffraction patterns for MnO are included because they illustrate the case of polyatomic crystals and the phase reversal of neutron scattering for certain scattering centers. MnO crystallizes in a face-centered cubic structure (similar to that of NaCl), and the X-ray pattern for this substance is typical of this class of structures. The neutron diffraction pattern is markedly different, however, with peaks

of high intensity at odd-indexed locations, while the even-indexed reflections are quite weak. This is an indication of the reversed phase of neutron scattering by manganese nuclei as referred to the scattering by oxygen nuclei. Theoretical considerations show that such a phase reversal is obtainable only in the close vicinity of a scattering resonance, and since this condition is met infrequently, only a few nuclei show the reversed scattering phase. No additional information on the structure of Cu or MnO is available from the neutron diffraction patterns, but the coherent scattering cross sections of neutrons by these nuclei have been determined from these patterns, and this is of interest as a nuclear physics study.

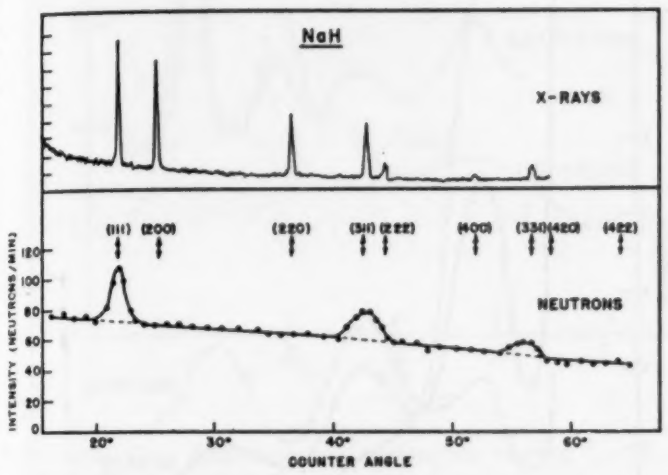

FIG. 7. X-ray and neutron powder diffraction patterns taken with NaH. The X-ray pattern is characteristic only of Na scattering, and the difference between the two patterns shows the influence of neutron scattering by hydrogen.

There appear to be many applications where the neutron techniques can usefully supplement the X-ray and electron diffraction procedures in the determination of crystallographic structures. As two examples of such applications, we shall mention studies on the determination of hydrogen atom positions in NaH crystals and on the order-disorder structure of Fe-Co alloys. Fig. 7 shows the X-ray and neutron diffraction patterns for a sample of NaH. Because of the very low X-ray scattering power of hydrogen compared with that of sodium, the X-ray pattern for NaH is characteristic only of the sodium positions in the crystal, and this has been determined to be of the face-centered cubic type. The pronounced difference between the X-ray and neutron patterns shows, however, that hydrogen scattering is contributing to the latter pattern, and a detailed study of the pattern intensities establishes that the structure is similar to that of NaCl. Thus, the hydrogen centers are located at positions in the crystal similar to those occupied by the chlorine centers in NaCl. From the neutron diffraction pattern of NaH it has been possible to evaluate the coherent scattering amplitude for neutron scattering by hydrogen, and, as shown in Table 1, this value is conveniently near those of other nuclei. The crystallographic location of hydrogen positions in more complex crystals (for instance, those of organic nature) should therefore be readily feasible with suitable neutron techniques. The structure of ice has been studied by the X-ray diffraction technique, and although it has been possible to locate the oxygen positions, this method gives no information about the location of the hydrogen atoms. A preliminary investigation of the structure of D_2O ice by neutron diffraction shows that considerable information on the location of the deuterium positions can be obtained by this technique.

In the study of the structure of alloys there is frequently encountered ordered solid solution in which one atomic species locates itself preferentially with respect to another species. In the system Cu_3Au for instance, heat treatment below 400° C produces an ordered structure in which gold atoms are located at the corners and copper atoms at the face-centered positions of a simple cube. Heat treatment at higher temperatures, however, produces a random substitution of gold atoms for the copper atoms in the normal copper lattice. The X-ray diffraction patterns for the ordered and disordered structures are materially different, and it is therefore easy to identify the individual structures. With the alloy FeCo, on the other hand, it is very difficult to distinguish between an ordered or disordered structure with X-rays, because the atomic structure factors of Fe and Co are so

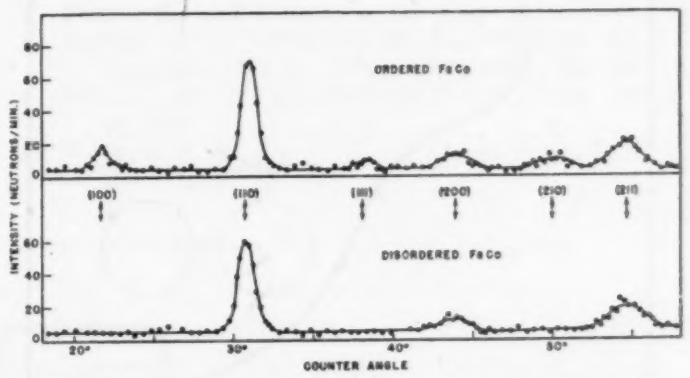

FIG. 8. Neutron powder diffraction patterns taken with samples of ordered and disordered preparations of Fe-Co alloys.

nearly alike. This similarity does not carry over to the neutron case, where the coherent scattering cross sections for Fe and Co are, respectively, 11 and 1.5 barns; in this case, therefore, it has been possible to identify the two structures. Fig. 8 shows neutron diffraction patterns for ordered and disordered samples of FeCo in which the additional diffraction features are to be noted for the case of the ordered sample. The ordered structure corresponds to a CsCl type of structure in which cobalt atoms are at the

centers and iron atoms are at the corners of simple cubes.

Scattering by Gases and Liquids

Measurements of the angular dependence of the scattering of X-rays by monatomic gases give the atomic scattering factors (see Fig. 3) from which the average electron distribution in the atoms can be calculated.

Similar measurements with diatomic gas molecules constitute a direct method for measuring the distance between atoms in the molecule. Such measurements have been made with X-rays and with electrons, but so far they have not been made with neutrons because of lack of sufficient intensity. A rough comparison of the X-ray scattering curve for a diatomic molecule with the corresponding curves to be expected with neutrons can be made by reference to the well-known curves due to Debye (Fig. 9). The lower curve corresponds approximately to the X-ray case where

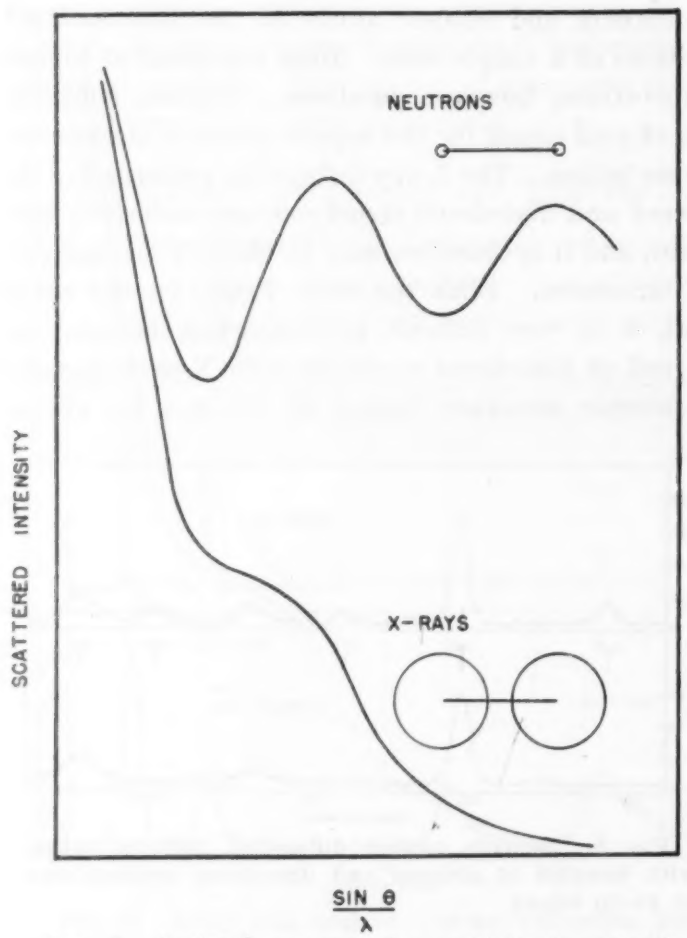

Fig. 9. Scattering curves for a diatomic molecule as calculated by Debye. The case where the atomic dimensions are comparable to the separation characterizes the X-ray scattering by a gas, whereas the case of point scattering corresponds to that expected with neutrons.

the scattering electrons are distributed within a volume comparable in size to the distance between atoms, while the upper curve, which is calculated for point scattering centers, corresponds more nearly to the neutron case in which the atomic nuclei are responsible for the scattering.

As the molecules to be studied by the diffraction technique become more complex, the data become more difficult to interpret, and a unique evaluation of the intermolecular spacings may not be possible. A rather simple polyatomic molecule which has been thoroughly studied by both the X-ray and electron diffraction methods is CCl_4 in the vapor state. A comparison of the coherent scattering of X-rays, electrons, and neutrons by CCl_4 will be made to illustrate the rather marked differences in the nature of the scattering curves to which the three radiations give

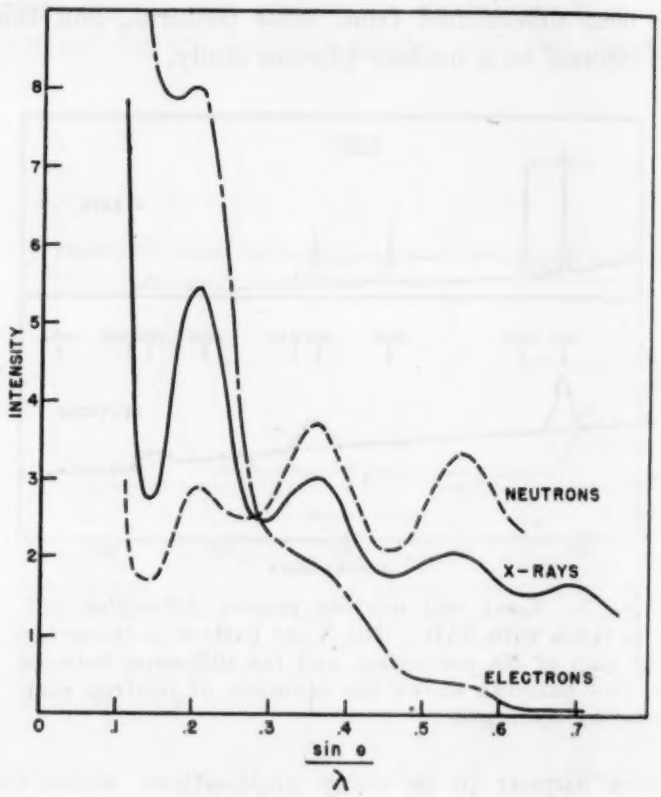

Fig. 10. Theoretical scattering curves for CCl_4 vapor for X-rays, electrons, and neutrons. The former two curves have been verified experimentally, while the latter has been calculated using the known neutron scattering amplitudes for carbon and chlorine.

rise. Fig. 10 shows the theoretical scattering curves for CCl_4 vapor for X-rays, electrons, and neutrons on an arbitrary scale. The X-ray and electron curves have been verified experimentally, while the neutron curve is calculated from the measured coherent scattering amplitude for carbon and chlorine. As one proceeds from electrons to X-rays to neutrons, the farther out peaks become more pronounced because of the nature of the scattering functions shown in Fig. 3. The sharper peaks which should be obtained with neutrons may lead to a higher resolving power for this radiation in molecular structure determinations.

Several studies have been made of the scattering of X-rays by CCl_4 in the liquid state. In this case there are, in addition to the interference effects between the various atoms in the molecule, the effects of interference between waves scattered by atoms in adjacent molecules. Fig. 11 shows an experimental

X-ray scattering curve for liquid CCl_4 and also a corresponding curve recently obtained for neutron scattering. The relative characteristics of the neutron

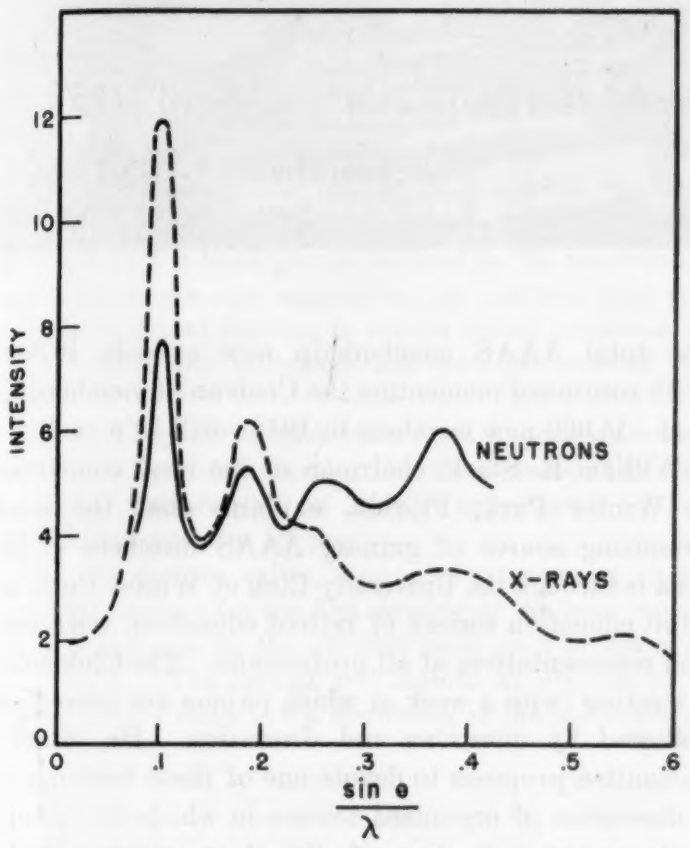

FIG. 11. Experimental scattering curves for liquid CCl_4 obtained with X-rays and neutrons.

and X-ray curves are seen to be similar to the corresponding curves for scattering by gaseous $C Cl_4$. Fourier analyses of the X-ray scattering data have given the spacings of the atoms in the molecule and also some information regarding the closer spacings for atoms in neighboring molecules. The neutron curve has not yet been determined with any great precision, and there remain some unsolved interpretative problems, but at a later date it will be interesting to compare the results of a Fourier analysis of the X-ray and neutron scattering curves.

CONCLUSIONS

The newly developing field of neutron diffraction would appear to have advantages over the older fields of X-ray and electron diffraction in some problems involved in the determination of crystal and molecular structures. The most important application for which this seems to be the case is in connection with the location of hydrogen or deuterium positions. So far, only very simple examples of such determinations have been carried out, but from these studies it would seem that there is no serious obstacle in the way of extending the technique to more complicated cases, especially where deuterated compounds can be used. If this is the case, neutron diffraction may become a very useful tool in the study of the structure of organic compounds. It must be borne in mind, however, that really rapid progress along this line cannot be expected, since in any case complicated structure determinations are very time-consuming problems; also, the very limited facilities for work in this field which result from the requirement of a chain-reacting pile as a source will make progress less rapid than in the corresponding fields of X-ray and electron diffraction, for which adequate sources can be procured by any laboratory.

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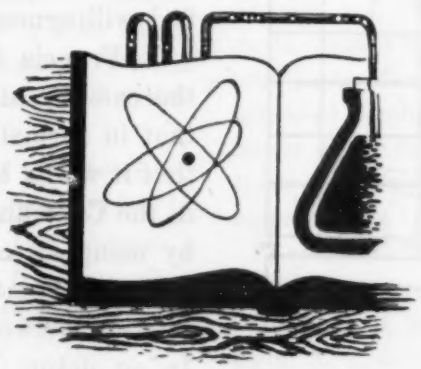

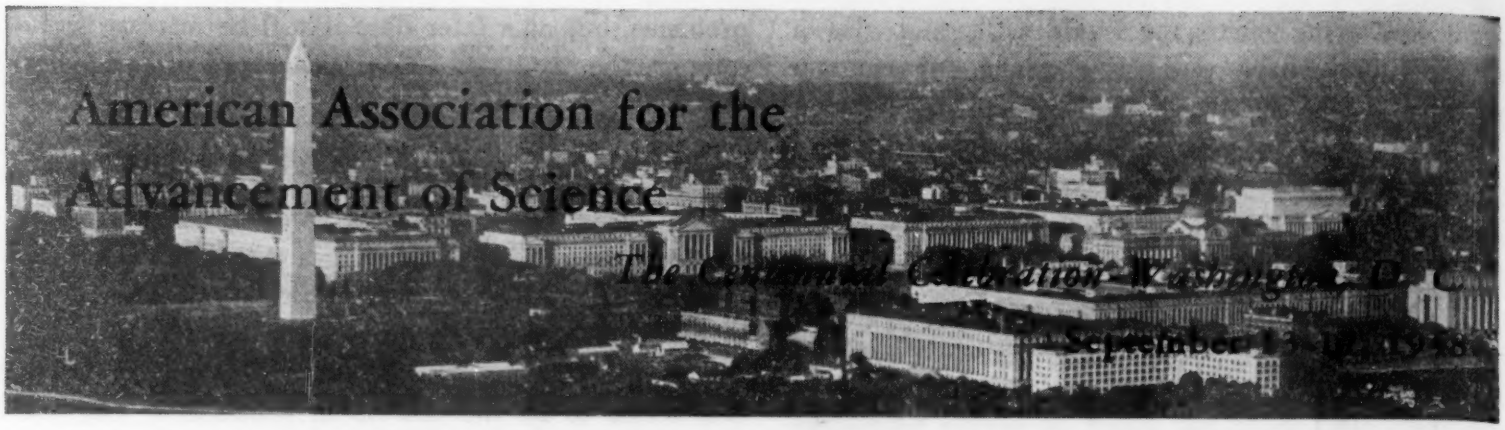

Centennial Membership Record

On display in the Washington office of the Association is a large map starred to show the distribution of local committees participating in the membership campaign. To date this graphic record of activities presents a most satisfying picture. Within the past two weeks, 28 new committees have been organized, making a total of 132 local committees which are now engaged in stimulating interest in the Association and its high objectives.

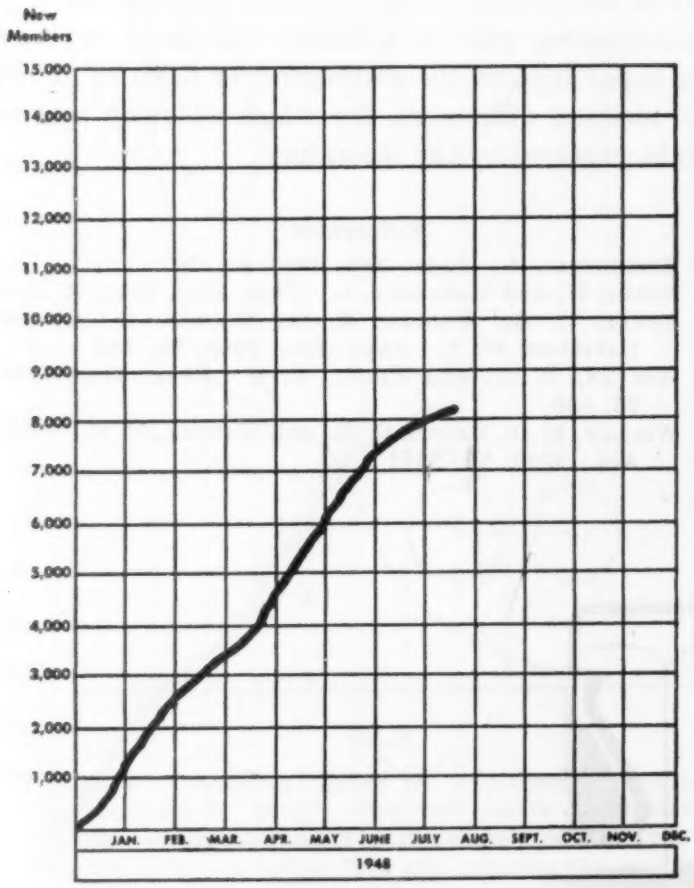

FIG. 1

Since publication of the last campaign report (*Science*, July 9, pp. 31–32) 1,154 additional individuals have joined the AAAS, bringing to more than 8,000 the number of new members who have joined between January 15 and July 15 (Fig. 1). The total AAAS membership now exceeds 40,000. With continued momentum the Centennial membership goal—15,000 new members in 1948—will be a reality.

William E. Stark, chairman of the local committee in Winter Park, Florida, explains that the most promising source of gaining AAAS members in his area is through the University Club of Winter Park, an adult education society of retired educators, scientists, and representatives of all professions. The Club holds a meeting twice a week at which papers are presented, followed by questions and discussion. Dr. Stark's committee proposes to devote one of these meetings to a discussion of organized science in which the history and present activities of the Association will be explained. Steps are being taken also to obtain the cooperation of other educational and professional groups in the Winter Park vicinity in promoting the objectives of the Association through increased membership.

Monroe J. Hirsch, of the Vision Laboratory, Stanford University, and H. W. Hofstetter, of the Ohio State University School of Optometry, have nominated for AAAS membership all the members of the American Academy of Optometry and proposed the formation of a committee designed to work with the various optometric groups in liaison between these groups and the Association. Both men have signified willingness to serve on such a committee.

J. Francis Hartmann, chairman of the group on the campus of the University of Minnesota, reports that in formal discussions thus far they have agreed that it would be desirable to stir up statewide interest in the Centennial Celebration and in science generally by using all communication outlets at their disposal to bring home to the people the increasingly close relation between science and their everyday affairs. In so doing, they plan to stress the work of the Association and its interest in admitting members who may not be professional scientists but who can benefit from membership.

C. J. Campbell and his colleagues in Detroit, Michigan, are moving in concert to make the Centennial

membership drive a successful one. Dr. Campbell's committee recently forwarded to this office many membership and personnel lists of industrial, scientific, and educational organizations in the Detroit area with the request that each person named be invited to join the AAAS. Quoted below in its entirety is the timely letter written by Dr. Campbell in organizing his membership committee:

An invitation is cordially extended to you to serve on a local membership committee of the American Association for the Advancement of Science. Although the functions of the local groups outlined in the accompanying enclosure are only suggestive, you will note that you are in a preferred position to inform others interested in science about the objectives and general work of the AAAS.

Your willingness to give time to a cooperative enterprise aimed toward increasing the effectiveness of science in human welfare will be greatly appreciated by our AAAS administrative officers.

In order that the writer, serving as a temporary chairman, may arrange for the first meeting of the local group, will you indicate on the enclosed card your pleasure in this regard. The agenda will include an election of a permanent chairman and a discussion of the operation of the committee. It is possible that most future business may be conducted by correspondence with an occasional get-together for inspiration.

It is the writer's personal feeling that since science has produced Atomic Power, which concurrently has implanted a growing fear of dire consequences in the minds of all of our people, it is the duty of each scientist to aid in allaying this fear. The participation in an effort to promulgate the understanding of science in just the way this committee will do, by increasing the membership of the AAAS, is most satisfying.

The task of sending invitations to innumerable nominees for AAAS membership is an onerous one. In a few instances acutely embarrassing situations have been experienced—that is, an individual has been invited to become a AAAS member when he or she already belongs to the Association. The names of all nominees for membership submitted to this office are checked against the master file of members before invitations are mailed, but it seems inevitable that some oversights will occur. The process of checking thousands of names is at best a very tedious procedure for the most competent clerical personnel. Therefore, we beg your indulgence in this connection.

Gordon Research Conferences

The program for the Gordon Research Conferences, currently being held at Colby Junior College, was published in the March 26 issue of *Science,* pages 308–312. At that time, however, the program for the Conference on Vitamins, to be held August 9–13, and that for the Conference on Instrumentation, August 2–6, were incomplete. The completed programs for these Conferences follow.

Conference on Vitamins

Floyd S. Daft, Chairman; E. E. Snell, Vice-Chairman

August 9 L. M. Henderson, "The Relative Value of Intact Proteins and Amino Acid Mixtures in Animal Nutrition"; D. W. Woolley, "Strepogenin"; Max Dunn, "Methods and Results of Amino Acid Assays"; Paul R. Cannon, "Current Problems of Amino Acid Utilization."

August 10 E. L. R. Stokstad, "The Biochemistry of Substances Antagonistic to Pteroylglutamic Acid"; O. D. Bird, "Pteroylglutamic Acid Conjugases"; Gladys Emerson, "Some Aspects of B_{12} Physiology"; Randolph West, "Clinical Results With Vitamin B_{12}." Discussion leader: William J. Darby.

August 11 Albert Tannenbaum, "The Role of Nutrition in the Origin and Growth of Tumors"; Philip R. White, "Mammalian Cellular Nutrition, an Objective and a Tool"; H. Trendley Dean, "Fluorine in Dental Health."

August 12 Karl Mason, "Patterns of Animal Response to Vitamin E Deficiency"; Hugh H. Darby, "Fate of Calcium in the Bone"; Elaine P. Ralli, "The Role and Effects of Pantothenic Acid in the Adrenalectomized Rat"; M. K. Horwitt, "Thiamin and Riboflavin Requirements of Man."

August 13 Herman C. Lichstein and Wayne W. Umbreit, "Enzymatic Functions of Biotin"; E. E. Snell, "Some New Nutritive Requirements of Certain Lactic Acid Bacteria." Discussion leader: Severo Ochoa.

Conference on Instrumentation

J. C. Peters, Chairman; H. C. Frost, Vice-Chairman

August 2 S. I. Reynolds, "Electrical Methods for Measuring Dielectric Constant and Conductivity of Liquids and Solids Over a Wide Range of Frequency"; A. H. Reesor Smith, "Application of Dielectric Constant and Loss Measurements to the Instantaneous and Unattended Analysis of Fluids"; William F. Bale, "Instruments Used for Measuring Radioactivity"; Clifford K. Beck, "'Tagged Atom' Analytical Techniques and Applications."

August 3 B. P. Dailey, "Basic Concepts of Microwaves as Applied to Instrumentation"; W. E. Good, "Solution of Measurement Problems With Microwaves"; Egon A. Hiedemann, "Principles of Measurements Made at Ultrasonic Frequencies"; J. C. Hubbard, "Application of Ultrasonics to Chemical Problems."

August 4 H. W. Bousman and E. H. Winslow, "Physical Analysis by X-Ray Absorption Techniques"; Harold W. Washburn, "The Mass Spectrometer in Isotope

Tracer and Complex Mixture Analysis''; I. M. Stein, Donald Williamson, and V. F. Hanson, Symposium on Problems Associated with the Development of Instruments for Research and Process Measurement and Control.

August 5 E. J. Rosenbaum, ''Raman Spectroscopy''; A. O. Beckman, ''Applications of Ultraviolet Spectrophotometry''; D. N. Hume, ''Amerpometric Titrations, and Applications of Self-Balancing Recording Potentiometers''; N. H. Furman, ''Electrical Methods of Analysis—A Brief Survey of Some Needs for Further Instrumentation.''

August 6 O. G. Koppius, ''Infrared Product Controller.''

Registration for several of the Conferences, namely, Corrosion, Instrumentation, Vitamins, Food and Nutrition, Medicinal Chemistry, and Cancer, has not been closed. Accommodations are available for a few registrants at each.

Requests for attendance at these Conferences or for additional information should be addressed to W. George Parks, Gordon Research Conferences, AAAS, Colby Junior College, New London, New Hampshire.

NEWS and Notes

George H. Hart, who for 22 years has headed the Animal Husbandry Division of the University of California College of Agriculture, has recently been named dean of the School of Veterinary Medicine, succeeding **C. M. Haring,** who became dean last year after serving for over 30 years as head of the Division of Veterinary Science. Dr. Haring retired as professor emeritus on July 1.

Ralph W. Clark, professor of pharmacy, University of Kansas, and **George M. Hocking,** professor of pharmacognosy, University of Buffalo, are visiting professors at the University of Mississippi during the Summer Session. Prof. Hocking will go to the University of New Mexico in September as professor of pharmacognosy.

Wallace W. Atwood, former president of Clark University, and Mrs. Atwood recently left on an 8-week summer field trip to the Rocky Mountains to continue his study of the physical evolution of the Rocky Mountain area.

Webster Chester, professor of biology at Colby College since 1903, retired in June. In recognition of his services the College conferred on him at its Commencement the honorary D.Sc. degree. A fund which now totals $700 is being raised by Dr. Chester's former students to purchase books for the Biology Department in commemoration of his long and distinguished period of service.

Ralph E. Grim, petrographer of the Illinois State Geological Survey and authority in the field of clay minerals, has been named a research professor of geology at the University of Illinois. He will teach graduate courses there while carrying on his regular work with the Survey.

Chandler McC. Brooks, associate professor of physiology at the Johns Hopkins University School of Medicine, who returned recently from New Zealand and Australia, where he spent two years as a Guggenheim Fellow, has been appointed professor of physiology and pharmacology and director of that department at the Long Island College of Medicine. **Arthur A. Siebens,** of Johns Hopkins, and **E. E. Suckling,** chief of the Electronics Laboratory, University of Otago, Dunedin, New Zealand, will join Dr. Brooks in this new enterprise.

A. Carlton Ernstene has recently been appointed head of the Division of Medicine at the Cleveland Clinic, Cleveland, Ohio. Prior to joining the Clinic staff in 1932, Dr. Ernstene was a member of the faculty of the Harvard Medical School.

Grants and Awards

The Engineering Foundation will sponsor 14 research projects for the year beginning October 1948. Grants have been recommended for the continuation of 12 of the past year's projects and for the support of 2 new ones. In selecting projects to be supported, preference has been given those of most fundamental nature, not ordinarily undertaken by industrial research organizations, in such fields as hydraulics, metal cutting, iron alloys, properties of gases and gas mixtures, riveted and bolted structural joints, reinforced concrete, welding, and properties of metals at different temperatures. The Foundation also provides limited financial support to projects of primary importance to a group of industries. Research is undertaken at universities and some engineering plants, in cooperation with the Foundation's engineering founder societies: the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers.

The Department of Chemistry, Carnegie Institute of Technology, has received $2,500 from the Research Corporation, New York City, in support of a project on ''Kinetic Studies of the Benzidine Rearrangement,'' now in progress under the direction of Robert B. Carlin.

The National Vitamin Foundation recently awarded new grants-in-aid, totaling $16,000, to scientists at four universities for vitamin research. Since March 1946, the Foundation has appropriated $126,320 for grants-in-aid on various research projects.

The new investigations involve eye health, the nutritional status of school children, the relationship between pyridoxine and fat metabolism, and the effects of time elements on the utilization of water-soluble vitamins. Working on these projects will be L. V. Johnson, assistant professor of ophthalmology, Western Reserve Univer-

sity School of Medicine; H. B. Pierce, professor of biochemistry in the College of Medicine, University of Vermont; R. S. Harris, director of the Nutritional Biochemistry Laboratory, Massachusetts Institute of Technology; and E. Geiger, professor of pharmacology and toxicology at the University of Southern California Medical School.

The Mt. Desert Island Biological Laboratory, Salsbury Cove, Maine, has received from the American Philosophical Society a grant of $10,000 for the establishment of the Ulric Dahlgren Memorial Fund, income from which will be used for scholarships at the Laboratory. The late Prof. Dahlgren, of Princeton University, devoted much of his adult life to the development and welfare of the Laboratory. He was president of the Corporation at the time of his death.

George H. Wise, associate professor of dairy husbandry at Iowa State College, received a $1,000 award from the American Feed Manufacturers Association at the recent Dairy Science meeting held at the University of Georgia. The presentation was made to Dr. Wise for his contribution to dairy cattle research over the past year. He has been principally concerned with soybean product factors involved in utilization of carotene and vitamin A in the dairy ration.

Andrew G. DuMez, dean of the School of Pharmacy, University of Maryland, and secretary of the American Council on Pharmaceutical Education, has been named 26th Remington medalist. In selecting Dr. DuMez, the Committee on Awards indicated that this distinction would be conferred "specifically as a recognition of his services as secretary of the American Council on Pharmaceutical Education," although "his general prominence in the fields of education and research also qualify him as a recipient of the medal." The gold medal award to Dr. DuMez will be made at the fall meeting of the New York branch of the American Pharmaceutical Association in New York City.

Frederick D. Richey of the Tennessee Experiment Station, USDA, recently received a distinguished service award from the U. S. Department of Agriculture for his work in organizing and leading the cooperative corn-breeding program resulting in the availability of hybrid corn.

Roy Winchester Crum, director of the Highway Research Board of the National Research Council, has been named the 10th winner of the Marston Medal for achievement in engineering at the recent graduation ceremonies of Iowa State College. The Marston Medal is annually awarded to an engineering alumnus of the College who has achieved recognition in his field.

Leslie G. S. Brooker, in charge of sensitizing dye research at the Kodak Research Laboratories, recently received the 1946 Henderson Award of the Royal Photographic Society of Great Britain. Dr. Brooker, 4th Kodak scientist in Rochester to win the award, was commended for his "outstanding work over a number of years on photographic sensitizing dyes, and especially on the relation between the color and constitution of such dyes."

Leroy R. Grumman, chairman of the Board of Grumman Aircraft Engineering Corporation, has been awarded the 1948 Daniel Guggenheim Medal for his work in aircraft design for Naval and peacetime use. The best-known Grumman planes are those used for carrier operations during the war, the torpedo bomber, TBF, and the fighters, F4F, F6F, F7F, and F8F.

Colleges and Universities

The new Aero Medical and Atmospheric Institute of the University of Illinois is expected to be completed in September. The $400,000 Institute, to be operated by the College of Medicine on the campus of the Chicago Professional Schools, will be used generally for the study of physical environment in health and disease. It will be equipped with apparatus for the study of cold, heat, and barometric changes of the body and of aviation medicine. **John P. Marbarger,** assistant professor of physiology at the University of Vermont, has been appointed director of research for the Institute and associate professor of physiology in the College of Medicine, effective July 1. While serving as an Army captain from 1943 to 1946 at the U. S. Air Forces' Aeromedical Laboratory, Wright Field, Dr. Marbarger conducted research in pressure breathing and thermal regulation under extreme environmental stress.

Ohio State University will launch a year-long celebration of its 75th anniversary on October 14 and 15 with addresses by distinguished speakers in the fields of science and technology, and man and society. Scheduled to appear on the program are Karl T. Compton, of the Massachusetts Institute of Technology, Mildred McAfee Horton, of Wellesley College, Reinhold Niebuhr, of Union Theological Seminary, Charles F. Kettering, research engineer, and James L. Morrill, of the University of Minnesota.

The University of Cincinnati Observatory recently acquired the only known copy of *Exposition of the discoveries and theories of modern astronomy,* a book written 100 years ago by the Observatory's founder, Ormsby MacKnight Mitchel. The volume was discovered in Mt. Lavinia, Ceylon, by A. T. G. Brito, who has presented it to the Observatory.

Facilities for research in the fields of rubber and plastics are being made available by the Wayne University Engineering Research Institute to firms wishing to submit problems for solution. Established during the war and since expanded, the Institute will now provide exploration of engineering problems in other specialized fields as well. The equipping and establishment of the plastics laboratory has been made possible through donations by the Detroit Rubber and Plastics Group, the Detroit Section of the Society of Plastics Engineers, and other industrial organizations. Personnel and research facilities are provided by the Institute, with Wayne faculty members acting as consultants and project engineers.

Two projects involving fisheries research, conducted by members of the University of Washington faculty, are now in progress. Under the leadership of Lauren R. Donaldson, director of the University's Applied Fisheries Laboratory, an expedition is visiting Bikini atoll to survey delayed

effects of the atomic bombs on surviving animal and plant life. The group will spend about 21 days collecting the radiobiological data which will be brought back to the Laboratory for analysis. A very great part of the federally-supported research on effects of radioactivity on marine life is being done at the University. In addition to those associated with the University, the party will include Asher A. White, University of Minnesota; Spencer W. Tinker, University of Hawaii; Theodore H. Bullock and Edward Held, University of California, Los Angeles; and George Hollenberg, University of Redlands.

A study of the great natural salmon runs will be made by the University's Fisheries Research Institute in a project supported by the Alaska Salmon Industries, Inc. According to the director of the Institute, William F. Thompson, research crews have been sent to southeastern Alaska, Kodiak Island, and Bristol Bay, Alaska, to investigate the problem of developing a permanent stabilized yield. Over recent years the salmon hordes have diminished to a great extent, and an attempt will be made to learn whether this is due to overfishing or to other causes. From the commercial catch, the crews will collect data on size, sex, age, and other factors of the run and study the spawning grounds for information about fluctuations of runs. It is hoped that this project will assist in developing conservation and proper use of natural resources.

Industrial Laboratories

Sweden's first penicillin factory has recently been completed in Stockholm by the biochemical industry, Kärnbolaget AB. According to the managing director of the company, David Isaksson, the capacity of the plant is sufficient to meet the country's total needs for penicillin, which in 1947 were estimated at 300,000 million international units, exclusive of that used for veterinary purposes.

Karl Cohen, head of the Theoretical Physics Group of the Standard Oil Development Company, has joined the staff of the H. K. Ferguson Company as technical director for atomic activities. Dr. Cohen has served as director of the Theoretical Division of the Manhattan Project Laboratory at Columbia University and as consultant to the Atomic Energy Commission on special problems at the Clinton and Hanford Laboratories. One of the projects of the H. K. Ferguson Company with which Dr. Cohen will be concerned is the construction of the first peacetime nuclear reactor at Brookhaven National Laboratory.

Meetings

The Electron Microscope Society of America will hold its annual meeting at the McLennan Laboratory, Department of Physics, University of Toronto, September 9–11. The program will include invited and contributed papers and a symposium on "Replica Techniques and Their Application," with S. G. Ellis, of the Radio Corporation of America, presiding. On Friday night, Sydney E. Smith, president of the University, will be host at a dinner in honor of those attending the meeting. An exhibit of electron micrographs has been planned, and the electron microscopy laboratory in the new E. F. Burton Wing of the Department of Physics will be open for visitors. Accommodations should be secured immediately, since the Canadian National Exhibit will be in progress in Toronto at the time of the meeting. A certain number of University residences will be available. Reservations for these may be obtained from Mrs. B. M. Deacon, Department of Physics, University of Toronto.

The 11th meeting of the Meteoritical Society, an affiliated society of the AAAS, will be held at the Institute of Meteoritics, University of New Mexico, Albuquerque, September 7–8. The sessions will open at 9:00 A.M. and 2:00 P.M. The scientific sessions will be open to the public, and all persons interested in meteoritics are cordially invited to attend.

The Second Inter-American Congress on Brucellosis will be held in Argentina the latter part of November 1948. The Inter-American Committee on Brucellosis has the active collaboration of the Pan American Sanitary Bureau in organizing the Congress under the auspices of the Argentine government. Everyone interested in the problems of brucellosis is invited to attend. The program will include sessions on research, epidemiology, clinical aspects of the human disease, and control of the animal disease. Arrangements are being made for Congress members to visit Argentine laboratories, dairies, and meat-packing plants, where serious brucellosis problems are encountered. Correspondence regarding the Congress should be addressed to Alice C. Evans, president, Inter-American Committee on Brucellosis, 2001 Connecticut Avenue, N.W., Washington 8, D. C.

A conference on Nuclear Physics and Low Temperatures will be sponsored by the Physics Division of Oak Ridge National Laboratory August 7–8. This is the first of series of physics conferences organized in response to the increasing interest in problems of this kind. The scientific sessions will be held in Oak Ridge on August 7 and the following day will be devoted to social events. The sessions and their respective speakers are as follows: morning session—"Alignment of Nuclear Spins," M. E. Rose, Oak Ridge National Laboratory; and "Nuclear Relaxation Phenomena at Low Temperatures," E. M. Purcell, Harvard University; afternoon session—"Thermal Equilibrium at Low Temperatures," H. B. G. Casimir, Philips Works, Eindhoven, The Netherlands; and "The Superfluid State," F. London, Duke University. Requests for housing and general information should be addressed to H. C. Maggart, Physics Division, Oak Ridge National Laboratory, P. O. Box P, Oak Ridge, Tennessee.

The New England Association of Chemistry Teachers will celebrate the 50th anniversary of its organization at its annual Summer Conference to be held August 23–28 at the University of Maine, Orono. One feature of the program is a symposium on "Correlation of High School and College Chemistry Courses," with William F. Ehret, New York University, Stuart R. Brinkley, Yale University, Frederic B. Dutton, Michigan State College, John C. Hogg, Phillips Exeter Academy, Ralph E. Keirstead, Bulkeley High School, and Dorothy W.

Gifford, Lincoln School, participating. In addition to that part of the program devoted to chemistry education, addresses will be made on such varied subjects as atom-smashing machines, tracer techniques, the newly discovered elements, the Antimalarial Drug Program, reaction rates and catalysis, paper chemistry, and porcelain enamel. Further information may be obtained from Robert T. Hart, Department of Chemistry, University of Maine, Orono, Maine.

The **American Mathematical Society** held a meeting at the University of British Columbia, Vancouver, on June 19, following the meetings there of the Royal Society of Canada. In the number of papers presented, the meeting was the largest yet held on the West Coast. The program featured an invited address by R. D. James, of the University of British Columbia, on "Recent Progress in the Goldbach Problem." The society plans to hold meetings in the Pacific Northwest at least every other year.

Deaths

Charles T. Knipp, 78, emeritus professor of physics at the University of Illinois, died July 6 in Denton, Texas. Dr. Knipp, who was known for his work on the conduction of electricity through gases and for his rain-making experiments, retired from the University in 1937.

Leo Winter, 58, chairman of the Department of Oral Surgery and director of the Postgraduate Division of the New York University College of Dentistry, died July 6 in Lawrence, Long Island.

Harold L. Weatherford, 57, assistant professor of anatomy at the Harvard Medical School, died suddenly July 7 in Boston. His chief interest was in the field of histology, and he had at one time served as associate editor of the *Anatomical Record.*

Clarence W. Balke, 68, research director of the Fansteel Metallurgical Corporation, North Chicago, for 30 years, died at his home July 8. Last January Dr. Balke received the Perkin Medal of the American Section of the Society of Chemical Industry for his metallurgical research which led to the production of tantalum in quantities sufficient for commercial use.

Anatole Kolodny, 55, died July 8 at his home in New York City. Dr. Kolodny, a practicing surgeon, was formerly affiliated with the Universities of Iowa and Illinois, where he taught anatomy and surgery.

Franz Weidenreich, 75, German-born anthropologist who was internationally known for his excavation and study of fossil man in China and Java, died July 11 at his home in New York City. Just before his death Dr. Weidenreich wrote an article on "The Human Brain in the Light of Its Phylogenetic Development," which appears in the August issue of *The Scientific Monthly.*

The 98-foot auxiliary ketch *Caryn,* latest addition to the fleet of the Woods Hole Oceanographic Institution, left on Monday, June 28, for a three-month deep-sea fishing expedition in the Bermudian area. Leader of the expedition, which is a joint project of the Chicago Natural History Museum and the Bermuda Biological Station for Research, Inc., will be Loren P. Woods, curator of Fishes at the Museum, who will be assisted by Fritz Haas, curator of Lower Invertebrates, and a number of other members of the Museum staff. Dugald S. Brown will supervise the Bermuda Biological Station's part in the expedition, which has been officially named the "Bermuda Deep-Sea Expedition, 1948."

Before sailing, the *Caryn* was fitted out with a heavy trawl winch containing 12,000 feet of $\frac{3}{8}$-inch wire. The fishing will be done with otter trawls, rigid frame trawls, and ring nets. The specimens collected for the Chicago Museum will be used for a projected Hall of Deep-Sea Life there.

William C. Schroeder, curator of Fishes at Harvard's Museum of Comparative Zoology, accompanied the ship on the voyage to Bermuda to test the nets and to acquaint the leaders of the expedition with the various types of equipment on board. This week's cover shows Mr. Schroeder on deck, examining some of the nets to be used by the Chicago scientists.

A national clearinghouse of information on the social sciences, to serve American colleges and universities, has been established by the Office of Education, Federal Security Agency. The announcement was made in connection with the appointments of Claude E. Hawley, former adviser in municipal government to Mayor Fletcher Bowron, of Los Angeles, as associate chief for social sciences, and J. Laurence Phalan, professor of economics at Middlebury College, Vermont, as specialist in economics, both positions being in the Division of Higher Education of the Office of Education. Under the direction of Dr. Hawley, the Section for Social Sciences now provides specialists in four fields: history—Jennings B. Sanders, economics—Dr. Phalan, geography—Otis W. Freeman, and political science—Dr. Hawley. Eventually, the Section will provide services for the fields of anthropology, psychology, and sociology. All of the specialists will be available to assist colleges in developing teaching and research techniques. One of the first projects of the Section will be a study of the implications of atomic development in the teaching of social sciences.

The Zoological Society of Bengal has this spring inaugurated publication of its *Proceedings,* to appear biannually. The journal will be devoted to scientific papers reporting the results of original zoological research which have been read before the meetings of the Society. The foreign subscription price is £1. In the first issue the Society announced plans for building up a reference library of its own because of the handicaps to Indian zoological workers which have resulted from inadequate library facilities and unavailability of current literature. The Society appeals to zoologists abroad to send any spare reprints for use in the library and to put the Society on their mailing lists. Correspondence should be directed to the Honorary Secretary, Zoological Society of Bengal, 35 Ballygunge Circular Road, Calcutta 19, India.

Comments and Communications

The Formation of Malignant Tumors in Mice by Deuteron-bombarded Methylcholanthrene

As part of a more general program on the effects of ionizing radiations on the carcinogenic activity of various organic compounds, it has been found that deuteron bombardment of 20-methylcholanthrene produces a product which our preliminary data show is more active biologically than the original substance.

Solid 20-methylcholanthrene was bombarded with the Crocker Radiation Laboratory 20-Mev deuteron beam[1] for a total of 0.58 microampere hr. The melting point of the product was approximately 10° C below that of methylcholanthrene. No charring of the sample was observed. X-ray diffraction patterns indicate the presence of not more than 15% of unchanged methylcholanthrene in the irradiated sample. Chromatographic separations of the methylcholanthrene showed that some impurities were present in the sample. This impurity is being investigated for chemical and biological activity. From the irradiated sample three distinct fractions could be separated. The identifications of the fractions obtained are being carried out. As would be expected, the irradiated sample showed only short half-life radioactivity, which had completely decayed out prior to injection.

TABLE 1

		Dose (mg)	No. of mice used	No. of tumors developed	Avg. wt. of tumors (gm)
Irradiated material	Males	0.25	5	4	14.25
		0.125	5	5	7.1
		0.0625	5	2	2
	Females	0.25	5	3	14.6
		0.125	5	3	13.9
		0.0625	5	3	7.5
Unirradiated material	Males	0.25	5	3	4.5
		0.0625	5	3	7.8
Controls	Females	0.125	5	0	Died from toxic effect or other causes
Olive oil Controls	Males	0.00	5	0	Still living

Mice[2] of the C-57 strain were used in the experiment and injected subcutaneously with various amounts of methylcholanthrene or irradiated methylcholanthrene (unseparated), as indicated in Table 1.

[1] We wish to thank Dr. J. G. Hamilton, of the Crocker Radiation Laboratory at the University of California, for his interest in the project and also L. W. Tuttle and R. Haymond for making the bombardments.

[2] The animal experiments were financed by a grant-in-aid from the Sigma Xi Research Fund.

The results in Table 1 indicate that there were significant increases in the size of the tumors with the irradiated material when compared with methylcholanthrene.

The malignant tumors produced by the irradiated sample and methylcholanthrene were of the same type—that is, fibrosarcoma. In two animals, in addition to the sarcoma, early epidermoid carcinoma was present. The systemic toxic effect of methylcholanthrene was reduced by irradiation when higher concentrations (0.125–0.25 mg) were used.

Detailed reports on the histopathology will be given elsewhere.

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Deformylation of 3-Formoxy Steroids on Activated Alumina

In discussing our experiments on the conversion of 3-formoxy steroids to 3-hydroxy steroids by chromatography over activated alumina (Fisher), W. Dasler (*Science*, April 9, p. 369) suggested that this deformylation is a special case of a more general hydrolytic splitting undergone by 3-hydroxy-steroid esters under these conditions. However, deformylation can be made to proceed quantitatively, whereas other ester groups are hydrolyzed only to a very minor extent. In fact, chromatography is a frequent means of purifying 3-acyl steroids. Therefore, aside from any theoretical implications, the deformylation reaction becomes of interest as a preparative tool in steroid chemistry.

There are a number of examples which indicate that the reaction is probably general. Cholesterol can be obtained quantitatively from cholesteryl formate (our unpublished observation). Ethyl-3(β)-formoxy-Δ^5-thiolcholenate gives ethyl-3(β)-hydroxy-Δ^5-thiolcholenate (Levin, *et al. J. Amer. chem. Soc.*, 1948, **70**, 511), and methyl-3(α)-hydroxy-12(α)-formoxy cholanate is obtained from methyl-3(α),12(α)-diformoxycholanate (Spero, McIntosh, and Levin. *J. Amer. chem. Soc.*, 1948, **70**, 1907). Additional studies are under way.

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On the Use of Roughage in Rat Diets

The following comments are added to those recently made by Davis and Briggs (*Science*, March 19, p. 292) regarding the note of F. Hoelzel and A. J. Carlson (*Science*, December 19, 1947, pp. 616–617) in their discussion of the "not uncommon type of error in the design of diets which makes the results of their use questionable." In this discussion Hoelzel and Carlson state: "A similar error, made by Guerrant and Dutcher (*J. Nutrition*, 1934, 8, 397), led to the erroneous conclusion

that cellulose had a vitamin B and G sparing effect.'' In this connection it is assumed that these authors were referring particularly to the following conclusion drawn by us (p. 418): ''Increasing amounts of fiber in the form of agar and Cell-U-Flour possessed a definite sparing effect on vitamins B and G utilization. The beneficial effect of fiber is thought to be due to the production of more favorable conditions for the growth of microorganisms in the digestive tract.''

A re-examination of the original data as well as those presented in Tables 1 and 2 (pp. 402, 403) and Figs. 5 and 6 (pp. 411, 413) seems to us to justify the above conclusion. (It is well to remember that at the time our experiments were carried out (1933) ''Vitamin B'' had not been subdivided into the numerous fractions known today.) To substantiate our contention, however, certain data taken from the original records (essentially as given in Table 2 of the above publication) are hereby presented:

Diet No.	Agar (%)	Cell-U-Flour (%)	Total food intake during depletion period (gm)	Growth during depletion period (gm)	Food intake per gm growth (gm)
337	0	0	73	4	18.25
338	2	.	76	7	10.86
339	4	.	77	10	7.70
340	6	.	86	13	6.62
341	8	.	79	17	4.65
342	10	.	75	16	4.69
345	..	2	65	7	9.29
346	..	4	67	13	5.15
347	..	6	69	13	5.31
348	..	8	74	19	3.89

These data show the average food intake and weight increase of the several groups of rats employed in this particular phase of our studies during that period (21-day depletion period) when no supplementary vitamin B or vitamin G was fed. Also, the relative amounts of the respective diets (including fiber, where the fiber replaced an equal weight of sucrose) ingested per gram gain in body weight are given. It is to be noted from these data that the rate of growth increased with an increase in the fiber content of the diet until 10% of the fiber (agar) was used. Since these diets had been proven to be deficient in the B-vitamins (Fig. 1), it seemed to us that the increased growth was due either to the sparing effect of the higher fiber diets on the body reserve of these vitamins or, more probably, to the increased intestinal synthesis of these vitamins in the presence of roughage. The authors favored the latter explanation.

When one considers the above data from the standpoint of the amounts of the respective diets ingested per gram increase in body weight, it is readily observed that the high fiber diets (8%) were more efficient in producing growth than was the basal diet (Diet 337) or the low fiber diets (Diets 338 and 345). This was previously shown by the relationship of caloric intake to growth (Table 2). This increased rate of growth per unit of food intake cannot be explained on the basis of the contention of Hoelzel and Carlson that ''the replacement of glucose by cellulose therefore reduced the carbohydrate content or increased the proportion of protein, fat, and other constituents of the utilizable part of the diet, and this may explain the results attributed to the cellulose.'' In fact, the replacement of 5–20% of sucrose by an equal weight of fat (Diet 319–323) failed to produce weight gains comparable to those obtained on diets in which 2–8% sucrose was replaced by a comparable weight of agar or Cell-U-Flour. Thus, the mere reduction in the proportion of the digestible carbohydrate content of the diet to the other digestible nutrients does not in itself explain the improved growth rates observed on the high fiber diets.

While the two sets of experiments were not carried out with the same objective in view or under comparable conditions, the writer has detected no conflict between the experimental findings reported by Mannering, Orsini, and Elvehjem (*J. Nutrition*, 1944, 28, 141) and those previously published by Guerrant and Dutcher (*J. Nutrition*, 1934, 8, 397).

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The Scientist and Social Issues

The excellent paper by Alfred B. Bonds, Jr., on ''Some Recommendations of the President's Commission on Higher Education'' (*Science*, April 16, pp. 379–383) contains a suggestion which leaves one with some misgivings. On page 381, this statement appears: ''In the physical and natural sciences, the Commission has put forward proposals aimed at equipping the prospective scientist with a broad understanding of the social issues related to his subject-matter field.'' One would hope this pronouncement does not in any way suggest that scientists be expected or urged to suppress or distort facts in such a way as to make them conform to a political or social ideology. The current effort in one of the totalitarian countries to shape scientists in this sort of mold will, one trusts, be forever frowned upon not only by scientists but by all thinking people elsewhere.

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TECHNICAL PAPERS

Insecticidal Activity of 2,2-*bis*-(2-Chlorothienyl)-1,1,1-Trichloroethane

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The preparation of several thienyl analogues of DDT was recorded by Metcalf and Gunther (*1*), who found that in residue tests 2,2-*bis*-(2-chlorothienyl)-1,1,1-trichloroethane was about 1/100 as toxic as *p, p'*-DDT on a weight basis to the greenhouse thrips, *Heliothrips haemorrhoidalis* (Bouché), and less than 1/1,000 as toxic to *Drosophila melanogaster* Meig. Subsequently, Truitt, *et al.* (*4*) repeated the preparation of this compound and stated that it was as active as DDT against cockroaches (unspecified species). Inasmuch as DDT is comparatively ineffective against the German cockroach, *Blatella germanica* (L.), we feel that this comparison is misleading with respect to the insecticidal potency of the compound and wish to record additional experimental data. The effectiveness of this thienyl-isoster of DDT is also of interest in clarifying the mode of action of DDT.

Toxicity tests were made on 10 species of insects as described in Table 1. In every case the insects were exposed to equivalent amounts of 2,2-*bis*-(*p*-chlorophenyl)-1,1,1-trichloroethane (m.p., 108–109° C), and 2,2-*bis*-(2-chlorothienyl)-1,1,1-trichloroethane (m.p., 65–66° C), in paired experiments carried out under identical conditions. The residue tests were made by placing the insects on crystalline deposits of the compounds on filter paper, deposited from standard acetone solutions. The tests using dusts were carried out with leaves dusted in a precision dusting tower. The potency of the thienyl analogue was comparable to that of DDT in tests with the German cockroach, red harvester ant, honey bee, and milkweed bug. Against the other species, DDT was markedly more effective. It is interesting that the insects against which the thienyl analogue was most effective are, with the possible exception of the honey bee, highly resistant to the action of DDT as compared with other chlorinated hydrocarbon insecticides. This is graphically shown in Table 2, where the activity of DDT is compared with chlordan (1,2,4,5,6,7,8,8-octachloro-4,7-methano-3a,4,7,7a-tetrahydroindane) and γ-hexachlorocyclohexane in the case of the ant and cockroach. It is evident that, compared in this way, chlordan and γ-hexachlorocyclohexane are each more than 1,000 times as toxic as DDT, on a weight basis, to these insects.

From the standpoint of the method of action of DDT, the behavior of the thienyl-isoster is of special interest. The dimensions of the thiophene molecule are nearly identical with those of benzene (*2*), and if it can be shown that the substitution can be made without altering the qualitative biological behavior of the compound, it may be indicative of the role of the aromatic rings as

TABLE 1

RELATIVE EFFECTIVENESS OF *p,p'*-DDT AND 2,2-*bis*-(2-CHLOROTHIENYL)-1,1,1-TRICHLOROETHANE TO VARIOUS INSECTS

Species	How tested	Mortality	
		DDT	Thienyl analogue
Apis mellifera L.—adult honey bee	Residue—1 mg/cm²	45%—5 hrs	40%—5 hrs
Pogonomyrmex barbatus (F. Smith)—adult red harvester ant	Residue—1 mg/cm²	35%—24 hrs	30%—24 hrs
Lucilia sericata Meig.—adult greenbottle fly	Residue—1 mg/cm²	100%—18 hrs	5%—18 hrs
Blatella germanica (L.)—adult German cockroach	Residue—1.3 mg/cm²	40%—120 hrs	50%—120 hrs
Oncopeltus faciatus (Dall.)—adult large milkweed bug	Residue—1.3 mg/cm²	90%—72 hrs	60%—72 hrs
Phryganidia californica Pack.—California oakworm, last larval instar	5% dust at 0.2 mg/cm² oak leaves	75%—96 hrs No feeding	None—96 hrs Heavy feeding
Listroderes obliquus Klug.—adult vegetable weevil	5% dust at 0.2 mg/cm² malva leaves	70%—96 hrs No feeding	None—96 hrs Heavy feeding
Apantesis proxima G. M.—last instar larvae	10% moist bran bait; fed 1 gm/larva	65%—96 hrs	2%—96 hrs
Tribolium confusum Duv.—adult confused flour beetle	(a) 2% in flour medium	100%—120 hrs	10%—120 hrs
	(b) Residue—1.5 mg/cm²	100%—48 hrs	2%—48 hrs
Aonidiella aurantii (Mask.)—first instar California red scale	Residue on grapefruit from xylene-water spray		
	0.4 gm/liter	98.8%—3 weeks	1%—3 weeks
	0.2 gm/liter	97.1%—3 weeks	None—3 weeks

...ncers'' for orienting the compound in some biological ...tem. A few experiments were carried out using the ...erican cockroach, *Periplaneta americana* (L.), as a ... animal and applying measured dosages of the thienyl ...pound exteriorly and by intra-abdominal injection. ...bias, *et al.* (*3*) determined the LD_{50} of DDT applied to ...*americana* in acetone as 10 μg/gm in 120 hrs. For ...T injected intra-abdominally the figure was 5–8 μg/gm. ...ng identical technics and amounts of acetone per ...ct, we obtained no response in 120 hrs from the ap...ation of 125 μg/gm of 2,2-*bis*-(2-chlorothienyl)-1,1,1-...hloroethane on the dorsum of the thorax near the ...nt of attachment of the wings, nor from the intra-ab...minal injection of 125 μg/gm of the compound between ...third and fourth abdominal sternites. Thus, DDT is ...h more effective to this insect both by contact and by ...ction than is its thienyl-isoster, and the failure of the ...er to produce symptoms at equivalent dosage cannot be ... to poor penetration into the insect.

TABLE 2

COMPARATIVE EFFECTIVENESS OF DDT, CHLORDAN, AND γ-HEXACHLOROCYCLOHEXANE TO GERMAN COCKROACH AND RED HARVESTER ANT

Insect	Toxicant as residue (μg/cm²)	Per cent mortality in 120 hrs		
		DDT	γ-Hexachlorocyclohexane (m.p., 112° C)	Chlordan (b.p., 175°/2 mm)
...*germanica*	1,300	50	...	...
	13	0	100	100
	1.3	..	90	70
	0.13	..	10	10
		Per cent mortality in 48 hrs		
...*barbatus*	500	0		
	13	..	90	65
	1.3	..	45	30
	0.13	..	10	15

...Yeager and Munson (*5*) studied the site of action of ...DT in *P. americana* and found evidence that DDT ...ted at a site common to the insect leg and body, viz., ... myoneural junctions of nerve fibers. A significant ...rtion of their evidence was the action of DDT in caus...g tremors and convulsions when applied to severed insect ...s. The application of the thienyl-isoster to the severed ...gs of *P. americana* at a dose of 100 μg/leg resulted in ...mistakable DDT-like, repeated, and spasmodic con...ctions of three-fourths of the legs treated. The dura...n and intensity of the movement was, however, much ...s than that produced by similar applications of DDT ... 10 μg/leg. This appears to demonstrate that 2,2-*bis*-...chlorothienyl)-1,1,1-trichloroethane affects insect nerves ...a manner similar, if not identical, to the action of DDT, ...t that the intensity of action is much less than one-...th that of DDT.

It may be concluded that 2,2-*bis*-(2-chlorothienyl)-1,1,1-...chloroethane is considerably less potent insecticidally ...an DDT, except when tested against insects highly re...tant to DDT. However, qualitatively it resembles DDT in its mode of action and appears to affect the same locus in the insect nervous system. This is evidence, therefore, that the phenyl rings are not essential in producing the biochemical effects of the DDT-type molecule.

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A Theory of Herbicidal Action

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Because there are many herbicides and many mechanisms involved in their action, generalization concerning them is hazardous. However, the contact sprays and soil sterilants are so dependent upon uptake by the plant that the mechanism of absorption is paramount to their effectiveness.

A theory proposing that nonpolar compounds can pass through the cuticle of leaves readily, whereas polar compounds enter with difficulty, has been published (*3*). Evidence is presented that nonpolar phenols in water, or in oil, are more toxic than their salts in water. Because such compounds (dinitrocresol, dinitrobutyl and amyl-phenols, pentachlorophenol, etc.) are more soluble in oil than in water, they are used to prepare either fortified oils or fortified oil emulsion sprays. Salts of these compounds in water are selective because, by differential wetting, they will kill broad-leafed weeds with no injury to grain, flax, etc. Lowering the polarity of the toxicants of such solutions by addition of acid salts (activation) or by using the ammonium salts increases their toxicity. Active absorption of the phenol molecules explains this increased toxicity where complete conversion to undissociated parent molecules is not accomplished.

Early testing confirmed this mechanism for 2,4-D compounds (*5*). The esters were more toxic than the ammonium salt, which exceeded the sodium salt. Many published results substantiate this relation. Early herbicides such as iron sulfate, sulfuric acid, sodium arsenite, and sodium chlorate entered plants because of their high concentration or corrosive action. Modern herbicides, such as dinitro- and chlorophenols, phenoxy compounds, and carbamates, are used at low concentrations; their entry from sprays into the plant depends upon their com-

[1] On leave from the College of Agriculture, University of California, Davis.

A. Emanuelli, assistant agronomist in the Puerto Rico Agricultural Experiment Station, has cooperated in the current research reported in this paper.

patibility with the plant cuticle. Some will act in the dust form, where solubility in cuticle is not complicated by the presence of water.

The cuticle does not form a perfect covering, especially on young leaves. Only xerophytes like cactus have nonpervious cuticle; young leaves of mesophytic plants lose considerable water through the cuticle. This is why arsenic and chlorate from 1 or 2% solutions penetrate young leaves and also why the sodium salt of 2,4-D is so effective on young plants.

Roots are specialized for absorption of ions. Recent tests in Puerto Rico prove that sodium pentachlorophenate as a pre-emergence treatment through the soil is more effective than pentachlorophenol. The sodium salt is effective as a selective soil sterilant against weeds in robust crops such as corn or sugar cane. Pentachlorophenol in oil emulsion is more useful as a pre-emergence contact spray in onions and carrots. The sodium salt in the topsoil injured these fragile plants; pentachlorophenol was noninjurious (*2*).

Salts of 2,4-D are more readily absorbed from soil than the esters; the salts caused crippling of oats and corn to a much greater extent than esters. On the other hand, 2,4-D acid, its sodium salt, and its methyl ester caused equal toxicity to oats, sunflowers, and peas in California soils compared on an acid-equivalent basis (*4*). Apparently the acid is sufficiently soluble to cause normal toxicity to the highly sensitive roots; the ester hydrolizes to an equivalent concentration. No leaching occurred from the cultures.

There are two possible pre-emergence methods: (1) pre-emergence contact spray to kill weed seedlings that have grown since preparation of the seed bed; (2) selective sterilization of the soil to kill weeds with little or no harm to the crop. Pre-emergence contact sprays can be used safely provided a nonpolar or water-insoluble toxicant is employed. Sodium cresylate and pentachlorophenate have proved harmful to seedlings of lettuce, onions, and carrots when a light shower occurred soon after application. Corn, cotton, and soybeans may not be injured.

Successful selective soil sterilization depends on profound differences between the crop and weed in susceptibility, root location, or some other factor. Certain corn varieties allow treatment with enough 2,4-D to kill grass seedlings without injury to the crop (*1*). Sodium pentachlorophenate was used successfully in corn and sugar cane in Puerto Rico. Leonard (*6*) found ammonium dinitrobutylphenylate effective in cotton in Mississippi. Current use of 2,4-D in cane proves that the pure acid applied dry is more effective under humid conditions than the sodium salt applied in solution. Solubility as related to solution rate and loss by leaching is probably the critical factor. The salt was effective for two weeks, but with over 3″ of rain it was leached out, whereas the acid remained effective for over a month. To use pre-emergence treatments successfully one should understand the nature of the selectivity upon which success depends.

A valuable generalization concerning absorption of herbicides is: for penetration of the cuticle and absorption by foliage, nonpolar compounds should be used; for sorption by roots, polar compounds. Although solubi and differential wetting (dinitro selectives) may the usefulness of toxicants, and cost, availability, other economic considerations may justify exceptions, above rule provides a sound theoretical basis for dicting the herbicidal uses of various toxic materials.

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Progesterone in Blood Plasma of the Ovulating Hen[1]

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The occurrence of progesterone in the avian ovary the presence of luteal tissue implying secretion of hormone by the bird, has long been a debatable subj (*2, 5*) of much interest not only in connection with a reproduction, but also because of more general phy genetic implications emphasized by the remarkably di gent histories of the ova of birds and mammals follow ovulation. All previous attempts to identify luteal tis or progesterone in the bird's ovary have led to eit inconclusive or negative findings (see *2* and *5* for s maries). The results of tests reported here, howe demonstrate beyond reasonable doubt the presence progesterone in the blood stream of the regularly ovul ing hen, presumably still a proper representative of *A*

The 10 plasma samples examined came from 3 Wh Leghorn hens in which the interval between succes ovulations was ca. 26.5 hrs. Timing of withdrawal blood samples was referred to second ovulation of clutch (Table 1), but the same samples may also be c sidered as having been taken between 2 consecutive ov tions, ca. 6.5 hrs elapsing between withdrawal of samp 10 and 1. The choice of relatively close intervals betw times of withdrawal of samples 2–8 was predicated up the supposition that changes in progesterone levels mig most likely occur within this period.

Each plasma sample was prepared from 0.95 ml blood plus ca. 0.05 ml of sodium citrate, centrifuged

[1] This investigation was aided by grants from the C mittee for Research in Problems of Sex, National Resear Council, and from the James Hudson Brown Memorial Fu of the Yale University School of Medicine.

n after blood collection as possible, and kept at freez- temperature until tested. The samples were tested ording to a recently described method capable of de- ting 0.0002 μg of progesterone in 0.0006 ml of plasma l apparently specific for progesterone (*4*). In the rely qualitative tests reported on here, a positive reac- n indicates a progesterone concentration greater than 3 μg/ml of plasma; a negative reaction signifies that, progesterone is present, its concentration is less than 3 μg/ml of plasma.

The samples yielded 8 positive and 2 negative reactions Table 1). Some samples gave a positive reaction indicat- g progesterone concentrations well above 0.33 μg/ml of sma, but no attempt was made to quantitate this ies. The essential point is that the positive reactions ford apparently unquestionable evidence for the occur- nce of progesterone in the blood stream of the ovulating n.

It is significant that the 2 negative reactions were given samples taken at about the time of, or shortly follow-

TABLE 1

ROGESTERONE REACTION OF PLASMA SAMPLES TAKEN WITH REFERENCE TO ESTIMATED TIME OF SECOND OVULATION OF THE CLUTCH

Sample No.	Hen	Time of blood withdrawal referred to 2nd ovulation	Progesterone reaction*
1	A	11.5 hrs before	+
2	A	9.5 " "	+
3	A	8.0 " "	+
4	A	7.0 " "	+
5	A	6.0 " "	–
6	B	3.7 " "	–
7	B	1.7 " "	+
8	A	0.5 " after	+
9	C	4.5 " "	+
10	C	8.5 " "	+

*A plus sign indicates a progesterone concentration of ore than 0.33 μg/ml of plasma; a minus sign, a concentra- on of less than 0.33 μg/ml.

ng, release of ovulation-inducing hormone in so far as his has been estimated by injection procedures (*3*) and ypophysectomy (*6*). The occurrence of low values at o critical a phase of the ovulatory cycle may be taken s substantial evidence for ovarian, and most likely ollicular, origin of progesterone, an inference in good ccord with recent views of the mammalian follicle (*1*).

The observations which encouraged undertaking the ests reported here will be accounted for elsewhere in ome detail. Further tests are contemplated to determine he site or sites of origin of progesterone in the bird, as ell as exact concentrations of progesterone throughout he ovulatory cycle.

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Phosphorylase in Guard Cells

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In a previous report (*5*) a histochemical method was described for the detection of phosphorylase in plant cells and tissues. Briefly, the method consists of incubating free-hand sections of plant parts, previously freed

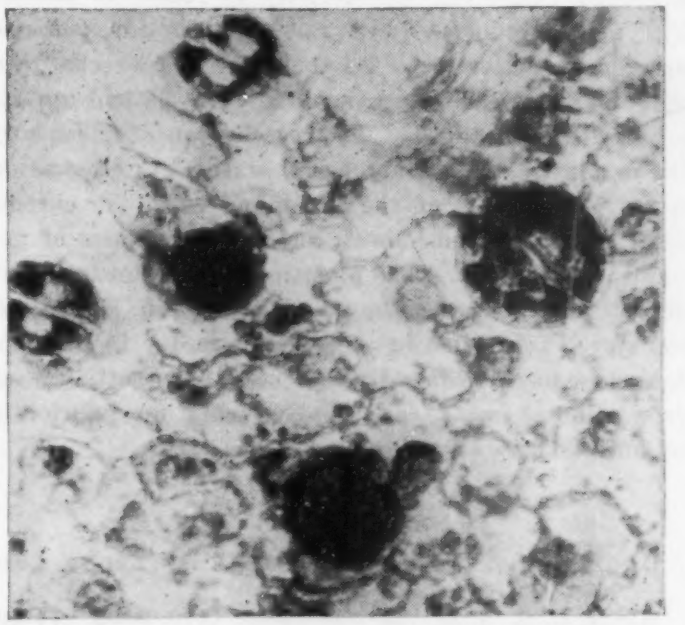

FIG. 1

of starch, in a buffered medium containing glucose-l-phosphate and subsequent staining with iodine in potassium iodide. Using this method, a number of experiments have been made. The results will be published elsewhere. The present note gives a brief summary of observations on plant epidermis.

Leaves of tobacco and broad bean were starved in darkness to free them of stored starch. The epidermis was stripped off and treated with glucose-l-phosphate as described above.

Very intense starch formation is found in the guard cells after 4–5 hrs of incubation, indicating the presence of strong phosphorylase activity. Little or no reaction is shown by the epidermal cells (see Fig. 1). Incubation with glucose instead of glucose-l-phosphate with or without the addition of magnesium salts and adenosinetriphosphate fails to give rise to starch even after 24 hrs. The result indicates that the guard cells

possess no detectable phosphorylating mechanism, although they show some phosphatase activity (*4*). The high concentration of phosphorylase in the guard cells suggests that the enzyme may play a part in the osmotic changes of the cells and therefore in the movement of stomata. Experiments along this line are now in progress.

Closer observations reveal that the phosphorylase activity is exclusively localized in the chloroplasts. It is especially clear in cells which have been incubated for but a short time before too much starch has been accumulated (Fig. 1). No activity is found in the nucleus and cytoplasm (*1*). Each chloroplast possesses one or more active loci. As the reaction proceeds, these loci enlarge and merge so that the whole plastid appears to be filled with starch. The localization of phosphorylase in plastids is further corroborated by observations on the chloroplasts of the mesophyll cells, the chromoplasts of Tropaeolum flower, and the leucoplasts of germinating seeds (*4*). The phenomenon is therefore quite general and confirms the anticipation of Hanes (*2*) that starch formation in the plastids is due to the phosphorylase mechanism. Unlike other intracellular enzymes, phosphorylase apparently bears no relation to the nucleus (*1*) or the mitochondria (*3*).

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Inadequacy of Proteolytic Enzyme Inhibition as Explanation for Growth Depression by Lima Bean Protein Fractions

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Discovery of the presence of trypsin inhibitors in soybeans (*3, 7*) and other legumes (*2*) and the ability of concentrates of these factors to inhibit growth in rats (*11*) and chicks (*8*) have stimulated interest in the mechanism involved in the poor nutritional values of the proteins of raw legumes.

An obvious hypothesis is that these bean fractions exert growth-inhibiting effect through their ability to inhibit normal enzymatic protein hydrolysis in the intestinal tract. This report concerns experiments with hydrolyzed proteins which have given results contradictory to that hypothesis.

Desikachar and De (*6*) have recently reported that active extracts of the soybean trypsin inhibitor had a pressing effect on the biological value of papain-dige soybean meal essentially equal to their effect on u gested meal. The two values reported, 45.9 and 4 respectively, were quite low, and presumably much lo than a value for undigested soybean meal in the abs of the inhibitor fraction would have been if data on n a positive control had been obtained. Although th data suggest that the low biological value of raw legu is not due primarily to inhibition of enzymatic digest it must be pointed out that several studies (*1, 4, 9,* have shown that papain, at a maximum, hydrolyzes o one-half to two-thirds of the peptide bonds in casein other proteins. Also, solubility of 91.6% of the nitro of the papain digest in 7% trichloroacetic acid, used Desikachar and De to estimate completeness of hyd ysis by papain, does not preclude the existence of so soluble peptides (*1, 5*).

Hence, the possibility has remained that the low b logical value found for the papain-digested meal was to inhibition of hydrolysis of residual bonds. As a p of our continuing study of the growth inhibitors legumes, we have carried out experiments that elimin this possibility in so far as trypsin-inhibiting activity tained from lima beans is concerned.

Lima bean protein fractions that contained high *vitro* trypsin-inhibiting activity and also high grow inhibiting activity in normal diets were fed to rats diets containing completely acid-hydrolyzed casein as sole source of nitrogen. In addition to nitrogen-c tributing components, the diets contained, in per ce cottonseed oil, 5; U.S.P. cod-liver oil, 2; salt mixt (McCollum's No. 185 plus trace elements), 4; dr liver extract (Wilson), 0.4; protein-free yeast extr equivalent to 2% yeast, and, as mg%, α-tocopherol, choline chloride, 150; inositol, 100; thiamin hydrochlori 0.5; riboflavin, 1.0; pyridoxin, 0.5; nicotinic acid, 1 calcium pantothenate, 2.5; *p*-aminobenzoic acid, 7.5; methyl-1,4-naphthoquinone, 0.2; biotin, 0.01; and su cient equal-weight mixture of corn starch and cane sug to make 100%. All diets contained 15/6.25% = 2.4 nitrogen, made up in diets 1 to 5 from 0.4% *dl*-tryp phan, 0.6% *l*-cystine, and 20% casein hydrolysate and diets 6 and 7, from commercial casein, plus, in both cas the nitrogen contributed by the lima bean fraction wh present. The lima bean fraction was added to the di without an equivalent deduction in amount of case hydrolysate nitrogen in order to eliminate the possibili that the inhibiting effect would be even partly due to lowered concentration of available amino acid or prote nitrogen in the diet.

Casein hydrolysates were prepared by autoclaving co mercial casein with four parts of 9N H_2SO_4 at 15 l of pressure for 18 hrs. The sulfuric acid was remov with barium hydroxide to a pH of 4 to 5, and the resul ant filtrate was concentrated *in vacuo* and dried from th frozen state. The completeness of hydrolysis was ver fied by amino nitrogen analyses, which indicated 71–74 of total nitrogen present as amino nitrogen (*13*).

A modification of Kunitz' (*10*) method of isolating th

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globulin-trypsin inhibitor from soybeans was used to prepare a lima bean protein fraction with a high trypsin-inhibiting activity. Ground lima beans were extracted with dilute acid, and the active factor in the extract adsorbed on bentonite, eluted wih aqueous pyridine, dialyzed free of pyridine, precipitated by ammonium sulfate, dialyzed salt-free, and dried from the frozen state. *In vitro* tests with crystalline trypsin and casein substrate indicated that this preparation produced 95% or more inhibition of one-fifth of its weight of crystalline trypsin protein.

The experimental diets were fed to groups of 10 albino rats (5 males and 5 females per group, with an average initial weight of 80 gm) for 6 days, during which daily records were kept of food consumption per group and weight of the individual rats. Experiments of this nature, carried for as long as 7 weeks in this laboratory, have conclusively demonstrated that results after 5 days are completely indicative of the relative values after 6 weeks or longer. Litters were divided between groups so that comparison between litter mates was possible; however, results on this basis did not differ significantly from those based on average weight gain per group.

The results of two experiments are presented in Table 1. Experiments A and B were run with different batches of casein hydrolysate and with different amounts of added tryptophan, which may explain the relatively minor quantitative differences in some cases. The lima bean fraction produced a marked depression of growth when fed at both the 1.6 and 3.2% levels. Growth rates on diets containing the heated, and hence inactivated, lima bean fractions were essentially equal to the rate on the basal diet. The growth-depressing effect of the lima bean fraction in the hydrolysate diet was equal to, or greater than, the effect in the diet containing the unhydrolyzed protein. These results are consistent with the hypothesis that lima bean protein fractions that have exceptionally high trypsin-inhibiting activity exert their major growth-inhibiting effect through some mechanism not directly related to the inhibition of the normal enzymatic hydrolysis of dietary protein. A more extensive study of the growth-inhibiting effect of crude and purified lima bean protein fractions will be published at a later date.

TABLE 1

GROWTH INHIBITION PRODUCED BY LIMA BEAN PROTEIN FRACTIONS IN RATS ON CASEIN HYDROLYSATE DIETS

Group	Nitrogen source	Feed consumption (gm/rat/day) A*	Feed consumption (gm/rat/day) B	Weight gain (gm/rat/day) A	Weight gain (gm/rat/day) B	Gain in weight (gm/gm N consumed) A	Gain in weight (gm/gm N consumed) B
1	Casein hydrolysate + tryptophan + cystine	8.5	9.3	3.3	2.5	16.1	11.2
2	" + lima bean fract., 1.6%	7.2	...	1.7	..	8.6	...
3	" + lima bean fract., 1.6%, heated at 15 lbs steam for 30 min	8.0	...	3.4	..	15.8	...
4	" + lima bean fract., 3.2%	6.7	7.6	1.1	0.3	6.0	1.1
5	" + lima bean fract., 3.2%, heated at 15 lbs steam for 30 min	8.4	10.0	4.1	3.3	18.2	11.2
6	Commercial casein	9.0	11.1	3.5	4.4	16.2	16.5
7	" " + lima bean fract., 3.2%	7.3	8.8	1.1	1.5	5.0	5.7

* Experiment A, 0.4% tryptophan, 0.6% cystine; Experiment B, 0.25% tryptophan, 0.8% cystine.

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IN THE LABORATORY

A Device for Obtaining a Continuous Record of Body Temperature From the External Auditory Canal

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University of Texas, Austin

We were interested in devising a method whereby continuous records of body temperature might be obtained from a human subject without interfering with his normal activities and comfort. It occurred to us that the external auditory canal might constitute an opening from which reliable measurements of the body temperature could be obtained, and it is obvious that the encumbrance of one ear canal with a temperature-sensitive apparatus need not interfere with an individual's normal activities.

The temperature-sensitive element used was a Western Electric V611 thermistor of the type originally devised for use in measuring skin temperatures. This thermistor is disk-shaped, about 6 mm in diameter and 1 mm thick. It has a resistance at 38° C of 450 ohms and a temperature coefficient of −4.0%/°C. This resistance element was embedded in the surface of a specially fitted plastic ear mold of the type used with electronic hearing aids.

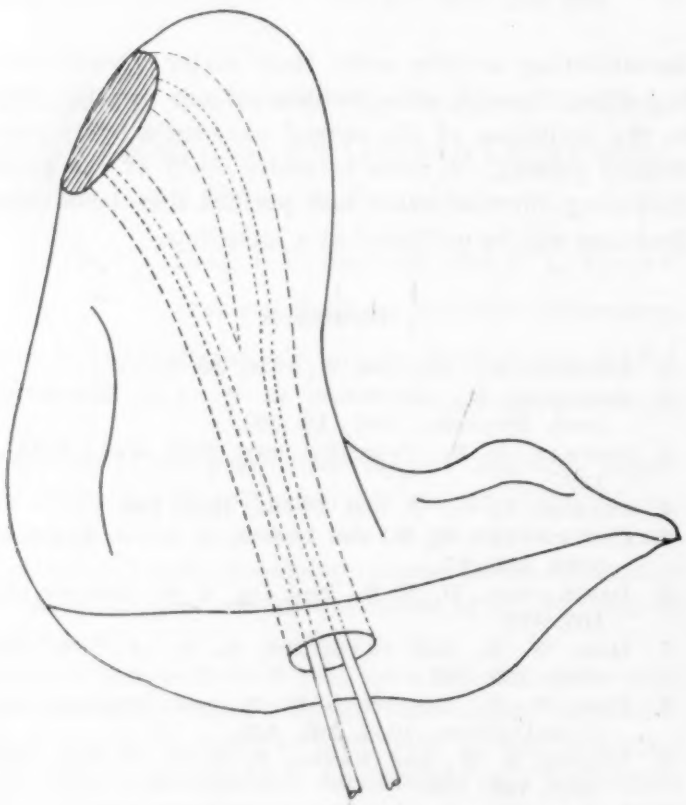

FIG. 1

Details of the arrangement are shown in Fig. 1. The flat surface of the thermistor provides a relatively large area for contact with the auditory canal, and the plastic plug, molded to the contour of the external ear, insulates the thermistor from environmental temperature fluctuations.

The thermistor and a recording microammeter were included in a Wheatstone bridge circuit as shown in Fig. 2, current being supplied by one or two 1.5-v dry

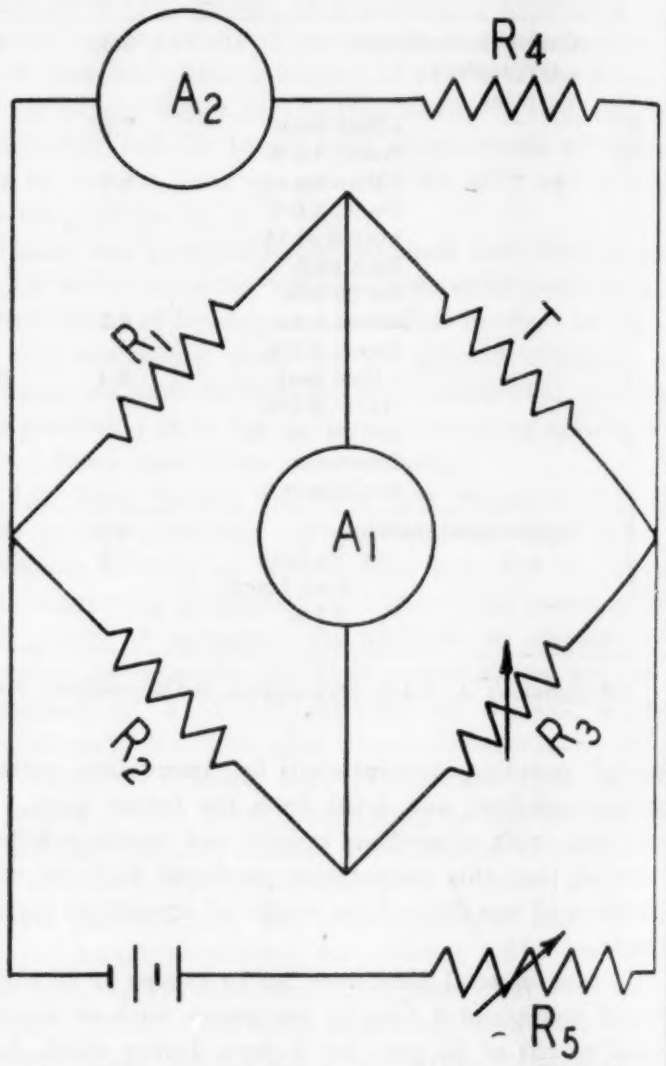

FIG. 2. A_1, recording microammeter; A_2, milliammeter; T, thermistor, 450Ω at 38° C; R_1, R_2, R_4, 1,000Ω; R_3, 0–1,500Ω; R_5, 0–500Ω.

cells. The recording instrument was a General Electric high-speed photoelectric recorder equipped with a microammeter having a full-scale sensitivity of 28 microamperes and a period of 1.2 sec. Temperature records are obtained on a tape about 4″ wide. The rheostat (R_5, Fig. 2) controls the current passing through the thermistor, and by adjustment of R_3 the desired range of temperatures can be centered on the tape.

The maximum sensitivity obtainable with the circuit shown in Fig. 2 corresponds to nearly 2″ on the tape/°C. The sensitivity is limited by the recording microammeter and by the amount of current which can be passed through the thermistor without causing appreciable heating of the element. We have usually operated the instrument with a current of 4.8 microamperes through

This results in a slight resistance heating of the thermistor. When in position in the ear, the increase in temperature from this source amounts to only about 0.05° C and is constant.

Our use of the instrument has thus far been limited to one individual, and extensive data have not been obtained. The auditory canal temperature was found in this case to be about 0.25° C lower than the sublingual temperature, which it parallels quite closely. The records

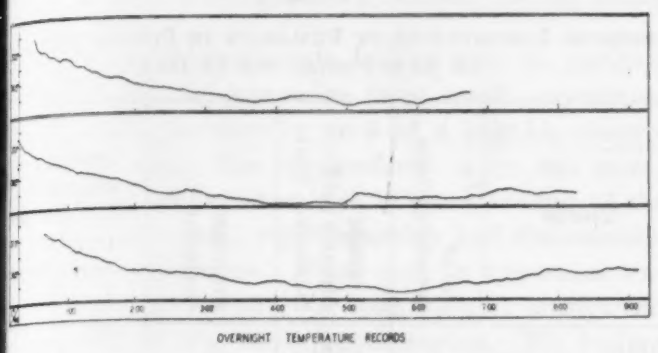

FIG. 3

reproduced in Fig. 3 will serve to illustrate the potentialities of the instrument. Three overnight temperature records are shown. For these measurements it was necessary to place adhesive tape over the ear and ear mold in order to prevent accidental removal during the night. This is unnecessary when the subject is awake. These records were obtained without discomfiture to the subject and without disturbing his sleep.

Use of X-Ray and Electron Diffraction as Methods of Analysis in Biochemical Chromatography

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The resolution and purification of biological materials by partition chromatographic techniques has become well established as a method of biochemical analysis. In particular, the development by Consden, Gordon, and Martin (1) of a chromatographic technique which employs strips of wet filter paper as the adsorbent has made possible a very effective method for separation of amino acids. These workers were able to show the presence of 22 amino acids in a single experiment, using a total of only 200–500 μg of sample.

This technique has been employed by several groups in this Laboratory for the separation and identification of amino acids in various biochemical studies. As a result, the problem of independent qualitative identification of the separated constituents of a mixture has become a problem of considerable importance. Various microchemical methods have been used, but the availability of only a few hundred micrograms of purified material makes such analytical techniques difficult.

Physical methods of analysis have also been considered. Among these, electron diffraction appeared to offer many advantages (*2*), the most attractive being its ability to yield diffraction patterns from minute quantities of material. Offsetting this advantage are the well-known difficulties of studying organic materials which are subjected to the bombardment of high-energy electrons. That this difficulty should not be underestimated is perhaps obvious from a casual study of the literature, which reveals a remarkable dearth of publications describing electron diffraction studies of solid organic substances. Nevertheless, it was decided to investigate the technique as a method for qualitative analysis of amino acids separated chromatographically.

A simple method of extraction of small quantities (ca. 200 μg) of an amino acid fraction from the chromatogram was devised. The care customarily exercised in the preparation of specimens for electron diffraction study was observed throughout. The portion of the filter paper containing the desired component of the mixture is cut out and placed in the fold of platinum foil, 1″ square, folded in half. Sufficient distilled water (ca. $\frac{1}{3}$ cc) is dropped on the filter paper to provide a slight excess over the amount absorbed by the paper. After leaching for several minutes, the water solution is dropped on a clean microscope slide or a piece of platinum foil which is immediately placed in a vacuum chamber. Under a moderate vacuum the water freezes rapidly and is removed by sublimation. A residue of minute crystals remains, and this specimen is suitable for study by electron diffraction techniques. This simple method apparently minimizes possible salt formation and contamination of the sample.

Specimens prepared in this way were examined in an electron diffraction camera, using 60-kv electrons and a specimen-plate distance of 65 cm. Considerable difficulty was frequently encountered in obtaining diffraction patterns, despite much effort to standardize very carefully the method of specimen preparation and manipulation. Patterns would appear momentarily and then disappear, a phenomenon which led us to believe that sublimation and/or decomposition of the specimen was occurring. Certain amino acids yielded excellent diffraction patterns with a minimum of effort; others required preparation of many specimens before any pattern could be obtained. The extreme inconsistency of the method was most discouraging, although results, when obtained, were fairly uniform.

While evaluating this situation, the possibility of employing X-ray rather than electron diffraction was discussed. Preliminary experiments were encouraging, and ultimately a very simple technique was developed. The vacuum recrystallized material is scraped from the glass slide and packed in a $\frac{1}{2}$-mm aperture centered in a brass disk 0.4 mm thick. This disk is centered in a recess at

[1] We desire to express our deep appreciation to R. G. Shepherd and P. H. Bell, of the Chemotherapy Division of these laboratories, for their assistance in providing samples of amino acids for analysis and for advice regarding chemical aspects of the problem.

the exit pinhole of a G.E. X-ray collimator, and the diffraction pattern is recorded on film in a G.E. flat cassette camera at a specimen-plate distance of 5 cm. Cu radiation (Ni filtered) at 40 kv and 20 Ma is employed. Exposure times are of the order of 4 hrs. Excellent diffraction patterns are obtained in this way from specimens representing not more than 50 μg of material.

Satisfactory, reproducible diffraction patterns have been obtained from a number of amino acids, including the following: *l*-leucine, *dl*-leucine, *dl*-isoleucine, *dl*-norleucine, *dl*-threonine, *l*-threonine, *d*-threonine, glycine, *d*-serine, *dl*-serine, *dl*-allothreonine, and α,γ-diaminobutyric acid dihydrochloride. Unknowns have been successfully identified by comparison with these standard patterns.

This investigation has yielded ample evidence that this method of X-ray analysis can be of tremendous value for the identification of small quantities of crystalline materials separated by chromatography.

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The Fumarate Content of Certain Tissues of the Rat as Determined by Partition Chromatography

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The importance of fumaric acid as a metabolic intermediate in the "citric acid cycle" has become well recognized during the past few years. Progress in this field, however, has been retarded by the lack of a quantitative method for the determination of the small amounts of fumaric acid and certain other related organic acids in the citric acid metabolic cycle. This report presents a new method which has proven satisfactory in our hands for the determination of fumaric acid in the small amounts present in the tissues of the rat and which, in preliminary studies, gives promise of being equally applicable to the simultaneous determination of succinic, malic, citric, and perhaps other organic acids in biological materials.

The present method employs the column partition technique of the English workers (*1, 2*). The method in its present form employs silica gel as an inorganic acid adsorbent which supports mechanically an aqueous phase (0.5 N sulfuric acid) that distributes solutes to a mobile nonaqueous phase (4–10% amyl alcohol in chloroform). The classical distribution law explains the partition that effects the separation of the organic acids in biological materials. The sequence of organic acids liberated the mobile phase from the vertical silica gel colum directly related to the distribution coefficients of solutes with reference to the system employed. Ci malic, lactic, succinic, *fumaric*, β-hydroxybutyric, ac and benzoic acids represent a partial list of tested a in inverse order of their release from the column. Ci acid is, thus, the last of this group to be rele Glutamic, aspartic, and nicotinic acids, like citric,

[1] U. S. Public Health Junior Research Fellow.

TABLE 1

Observed Distribution of Fumarate in Pooled Tissue 12 Rats Fasted for 18 Hrs

Tissue	No. of determinations	Average fumaric acid measured (μg)	Standard deviation	Average concentration of fumaric acid (mg/100 g wet tissue)
Brain	2	830	...*	15.0
Kidney	4	404	± 65	9.5
Liver	4	172	± 5.7	7.8
Gastrocnemius muscle	4	127	± 7.8	2.3
Blood	3	16		Less than 0.

* Range of measured values, 40 μg.

delivered after fumaric acid. The effluent acids titrated with 0.004 N sodium hydroxide. The posi of fumaric acid in the mobile phase emitted was veri by a supporting method of analysis, devised by us, ba on Steenhauer's microqualitative test (*3*) for fum acid.

When the fumaric acid emitted from the colum collected in successive small fractions having geom cally increasing volumes (e.g. were the first fracti ml, the next would be 1.13 ml, the next 1.26 ml, etc.), concentration of fumaric acid plotted against the frac number (1, 2, 3, 4, etc.) describes a curve which appr mates the normal curve of error. When the obser curve is fitted to a theoretical curve for fumaric a deduced from the binomial law, congruity measures reliability of the data.

Recovery studies have demonstrated the applicabi of these techniques to animal tissues. Data on fumarate concentrations in several tissues of the fa adult rat maintained on a stock diet are shown in Tabl Samples from the pooled tissues of the 12 rats were u

The foregoing data thus indicate that there is a nificant amount of fumaric acid present in the tissues the rat, particularly in brain, and furnish analytical s port for the current concept of the importance of t member of the "citric acid cycle" in metabolic proce Further studies on other members of the cycle are progress.

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pparatus for Semimicro Electrodialysis

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the course of experiments dealing with the purifica- and isolation of histamine from small amounts of gical fluids, we were in need of a suitable electro- is apparatus. The requirements to be met were: capacities of the chambers, efficient cooling of the rode compartments, rapid assembly and disassembly, all-glass construction. Since such an apparatus was available commercially, we designed and constructed which fulfills the above requirements. We believe the apparatus described, which has given entirely factory service, may be of value also in other work hich electrodialysis is employed.

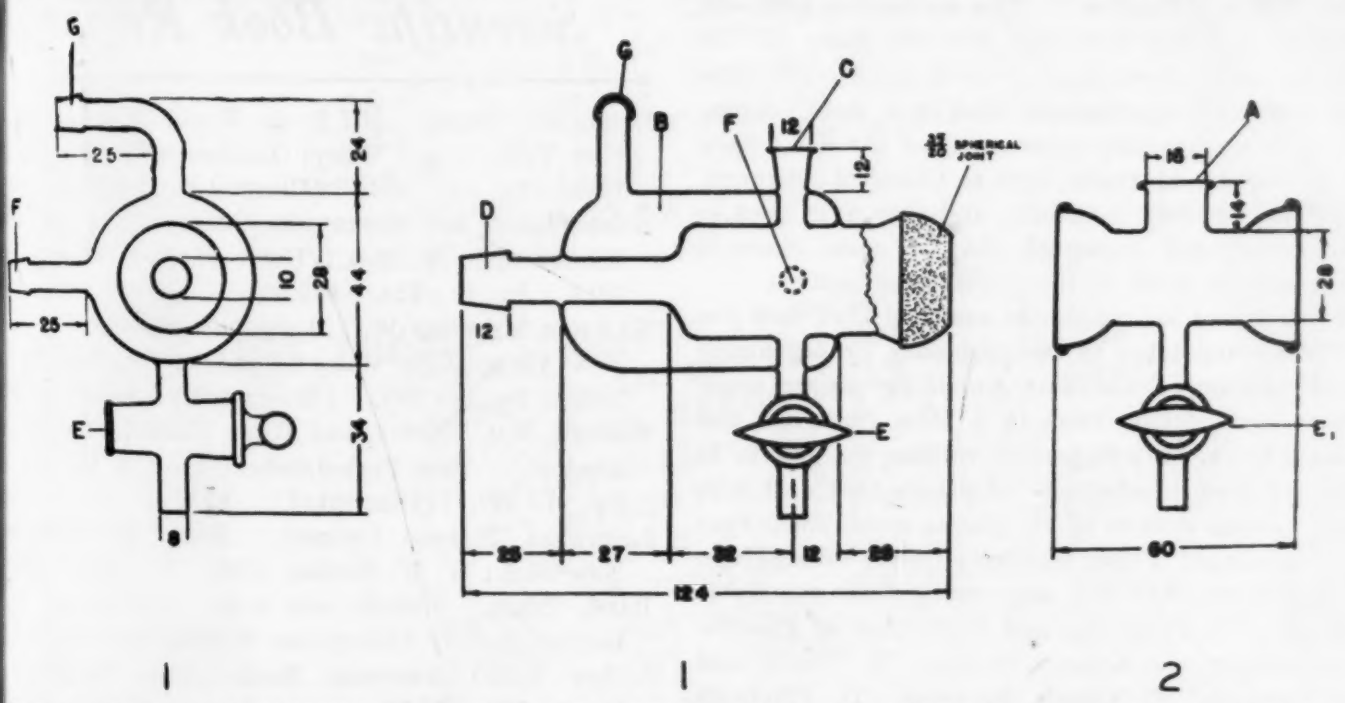

FIG. 1. Diagram of electrodialysis apparatus: 1, electrode chamber; 2, middle chamber. All dimensions in mm. ing measurements—outside diameter.

e apparatus is constructed from 35/20 Pyrex spher- joints on 28-mm tubing (Fig. 1). The middle cham- consists of two female joints, sealed together and ded with an opening (A) wide enough to admit a r and stopcock (E_1) for drainage. The electrode artments are constructed as shown in the drawing, the male joints to connect to the middle chamber. ent cooling is assured by the cooling jacket (B) into the electrode chamber is sealed. Chamber intake stopcock (E), and electrode lead-channel (D) of lectrode chamber are sealed through the cooling t, which is provided with cooling water intake (F) utflow (G). The top capacity of the middle cham- 20 ml, and volumes as low as 5 ml may be dialyzed.

The capacity of the apparatus can be modified by the use of different sizes of joints and tubing.

To assemble the apparatus, electrodes are introduced through the male joint opening and fastened by a rubber

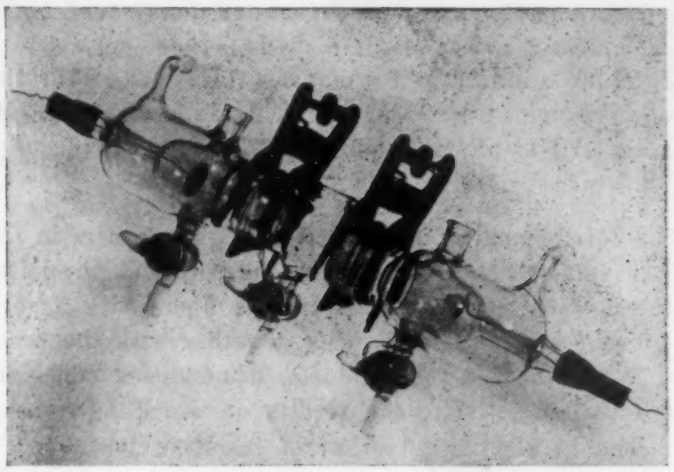

FIG. 2. Assembled electrodialysis apparatus.

sleeve over D. Alternately, a ground joint at D with sealed-in lead wire can be employed with a smaller electrode. The male joints are then lightly lubricated with silicone stopcock grease. Semipermeable membranes, cut circularly with a diameter not more than 2–3 mm greater than the inside diameter of the male joint, are soaked in water and laid on the joint, and the female half of the middle compartment is pressed in and firmly attached with a Thomas spherical joint spring clamp (#3421).[1] The other electrode is attached in a similar manner and the assembly shown in Fig. 2 transferred to a suitable support. A water hose is attached to one intake (F). Cooling water outflow (G) is connected to intake (F) on the opposite electrode chamber and the water led away from the outflow (G) on the same side.

[1] Obtainable from Arthur H. Thomas Company, West Washington Square, Philadelphia, Pennsylvania.

Book Reviews

The science of plastics: a comprehensive source book based on the original literature for 1942–1946. (Vol. 1.) H. Mark and E. S. Proskauer. (Eds.) (With the collaboration of P. M. Doty, V. J. Frilette and B. H. Zimm.) New York-London: Interscience, 1948. Pp. 632. (Illustrated.) $9.00.

The development of the theory of high polymers in the late 1930s furnished the research chemists and physicists in the fields of plastics, rubbers, and fibers with a very useful and powerful tool. This, together with the practical importance of the products, has induced considerable research activity, the results of which have been published in almost 100 different scientific journals.

The importance of these results, especially to workers on plastics, rubbers, and fibers, and the difficulty of keeping in touch with developments so widely published was appreciated by Prof. Mark and his associates. In consequence, in 1942 they started an abstract service, "Resins, Rubbers, Plastics." This service has been outstanding, due to the fact that not only have all the principal research papers been covered, but the abstracts include pertinent experimental and test data, curves, equations, cuts of special apparatus, and the like. Such details the regular abstracts, such as *Chemical Abstracts*, could not be expected to include, and they have been so well organized and presented that in most cases it is unnecessary to refer to the original publication.

Prof. Mark and his associates now feel that they can be of further assistance to the profession by organizing this vast number of abstracts, providing proper cross-references, and putting them in a form for quick and easy consultation. In the present volume, the first to be put out, are grouped abstracts of papers that deal with the more general aspects of the plastic state, under four principal headings. These, together with the subheadings, are so significant that they are quoted from the Table of Contents: "I. Properties and Evaluation of Plastics. A. Commentaries and General Studies. B. Tensile and Impact Strength. C. Elastic Behavior. D. Plasticity and Flow. E. Wearing Qualities. F. Electrical Properties. G. Thermal Expansion and Related Phenomena. H. Permeability and Sorption. II. Physical Chemistry of Polymer Systems. A. The Solid State. B. Solutions: Fundamental Theory. C. Solutions: Molecular Weight. D. Solutions: Viscosity. E. Solutions: Osmotic Pressure. F. Solutions: Light-Scattering. III. Kinetics of Polymerization Reactions. A. Mechanism and Kinetics of Visual Polymerization. B. Copolymerization Theory. C. Three-dimensional Polymers and Gelation. IV. Plastics Engineering. A. Solvents and Plasticizers. B. Laminates. C. Radio-Frequency Heating." The value of this classification to workers in the field is obvious.

The editors state that "papers that are restricted to studies on single plastics are reserved for Volume II. The chapters in the second volume accordingly will have titles such as 'Polystyrene,' 'Cellulose Plastics,' etc." Thus, it will be possible for workers to have or to co just the phase of the field most important to them.

The format is the same as that of the original l leaf abstracts put out by the Resins, Rubbers, Pla service; the type is a little small, but clear and re readable, and the reproduction of the curves, cuts, et quite good. The editors state that this was done to the cost down and thus bring the book within the r of more persons who need it—a commendable consi ation that will be generally appreciated. The boo sturdy and well bound and appears capable of ta the constant handling it is sure to get.

For all research workers in the field of polymer che try, this book is highly recommended. This could include those working with proteins, cellulose, and o natural polymers as well as those developing synth resins. Essentially it is an up-to-date reference lib on the theory and properties of high polymers.

GEORGE H. BRO
Western Regional Research Laboratory, USDA, Albany, California

Scientific Book Register

BURCHARD, JOHN. *M.I.T. in World War II: Q* New York: John Wiley; London: Chapman & H 1948. Pp. xvi + 354. (Illustrated.) $3.50.

HAHN, HANS, and ROSENTHAL, ARTHUR. *Set funct* Albuquerque, N. Mex.: Univ. of New Mexico Pr 1948. Pp. ix + 324. $12.50.

HAMMER, BERNARD W. *Dairy bacteriology.* (3rd New York: John Wiley; London: Chapman & H 1948. Pp. ix + 593. (Illustrated.) $6.00.

HARVEY, WM. CLUNIE, and HILL, HARRY. *Insect p* (2nd ed.) New York–London: Paul B. Hoeber, I Pp. xi + 347. (Illustrated.) $5.00.

LASSWELL, HAROLD DWIGHT. *Power and personal* New York: W. W. Norton, 1948. Pp. 262. $3.00

RADÓ, TIBOR. *Length and area.* (American Ma matical Society Colloquium Publications, Vol. XI New York: American Mathematical Society, 1 Pp. v + 572. $6.75.

SARTON, GEORGE. *Introduction to the history of sci* Vol. III: *Science and learning in the Fourteenth C tury* (in two parts). Baltimore: Williams & Wilk 1947. Pp. xxxv + 1018, Part I; xi + 1019–2155, P II. (Illustrated.) $20.00 per set.

SIRI, WILLIAM (with contributions by Ellsworth Dougherty, *et al.*). *Handbook of radioactivity tracer methodology.* (AF Tech. Rep. No. 56 Dayton, Ohio: Department of the Air Force Air M teriel Command, 1948. Pp. 867.

TRUESDELL, C. *An essay toward a unified theory special functions based upon the functional equa* $\frac{\partial}{\partial z}F(z,\alpha) = F(z,\alpha+1)$. (Annals of Mathematics, 18.) Princeton, N. J.: Princeton Univ. Press; L don: Geoffrey Cumberlege, Oxford Univ. Press, 19 Pp. iv + 182. $3.00.

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Reference: Tyner, Anal. Chem., 20, 76 (1948)

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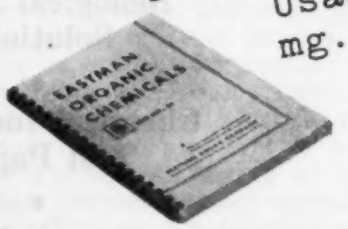

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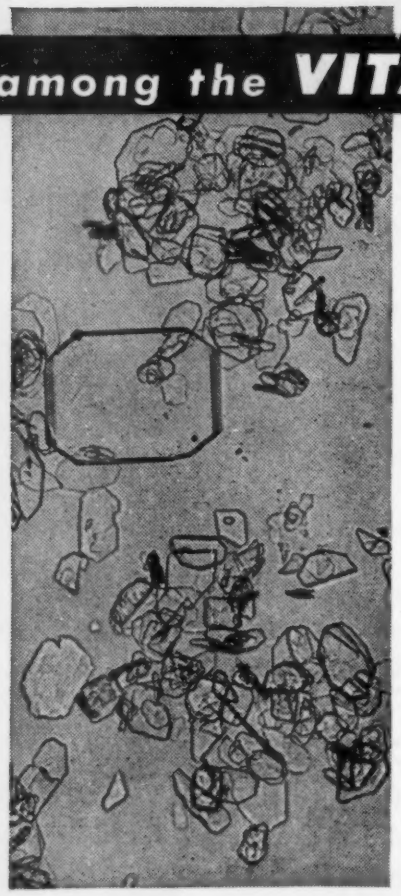

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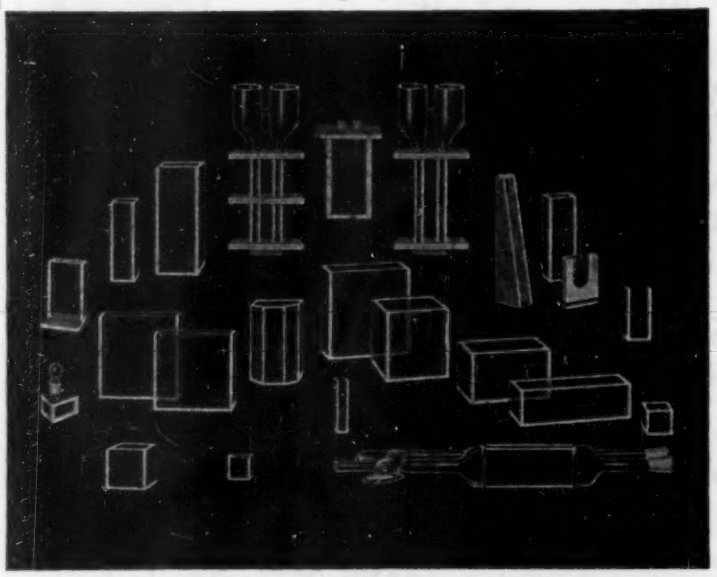

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Bureau of Mines

The Bureau of Mines, United States Department of the Interior, established by Act of Congress on May 16, 1910, has three primary functions—to conduct scientific and technologic investigations on the mining, preparation, treatment and utilization of minerals, to conserve mineral resources, and to promote safety in the mineral industries. Headed by a Director and an Assistant Director, the Bureau is composed of five major operating divisions and an administrative division.

Prevention of accidents in the mines, quarries and plants of the mineral industries has always been a major responsibility of the Bureau. To meet it, fundamental research has been done on all phases of mine and plant safety, including analysis and study of atmospheres and dusts; investigation of the properties of various types of explosives and other blasting materials; study of the factors that cause roof failure in underground mines; research to determine the characteristics necessary for electrical equipment to be used in explosive atmospheres, and much related work. The Bureau tests explosives, electrical equipment, and respirators, using standards based on its extensive research, to determine their permissibility for use in mines; inspects coal mines and gives appropriate advice for the correction of hazards discovered; and engages in safety educational work by holding demonstrations, issuing publications, and conducting first-aid, mine-rescue and accident-prevention courses for officials and employees of mines and plants.

Technologic and scientific research on coal and coal products is Conducted against a background of increasing scarcity of high-grade coking coal and growing demand for energy fuels. Investigations of reserves of coking coals and search for methods of treating low-grade coals so that they can be used, alone or in blends, in producing metallurgical coke are under way, as are studies directed toward developing more efficient mining methods that will reduce the average loss of 35 percent of the coal in the ground. The Bureau is determining and making available the analyses—proximate, ultimate, or both—of American coals, and conducts carbonization tests.

Problems involved in the production of synth liquid fuels from oil shale and coal are rece a great deal of study under a $60,000,000 prog authorized by Congress. An oil shale demon tion plant is in operation, the shale being m in what is in effect an underground qua Laboratory, pilot-plant and demonstration-p studies are being conducted on the productio synthetic liquid fuel from coal by the hydroge tion and gas-synthesis processes. Complete g fication of lignite has been accomplished o demonstration-plant scale, and encouraging sults have been obtained from the first experi in gasifying unmined coal. Further undergro gasification tests are contemplated.

Petroleum studies by the Bureau include siphon flowing of oil wells, recovery of oil f surface or near-surface oil-impregnated depo various secondary-recovery methods, the eff of sulfur in petroleum, and the thermodynamic hydrocarbons. Research on helium gas, of w the Bureau is the sole producer, includes ways using this inert gas in welding and metallurgy, traction, and new uses in tracing the flow of oil natural gas in underground reservoirs. Equip has been developed for large-scale productio 99.8 percent pure helium.

In laboratory and pilot plant, the Bureau striving to find improved methods of treating beneficiating ores, and to produce substitutes critical and strategic materials. Bureau scient have produced high-purity metals, such as e trolytic manganese, chromium and cobalt, f low-grade domestic ores and demonstrated th value for steel-making. They are continuing search on sponge iron, and have obtained prom ing results in treating oxidized lead-zinc ore e tro-metallurgically. The Bureau's work on me has included quantity production of titanium, which uses are being sought in cooperation with dustry, and research on extracting alumina fr materials other than bauxite and on upgrad marginal bauxite. Considerable research is be conducted on the so-called rare metals such thallium and gallium, the latter having the high liquid range of any known metal, and progress been made in isolating zirconium, which is one the two structural metals inert to hydrochloric ac